REPORT DOCUMENTATION PAGE			*Form Approved* *OMB No. 0704-0188*

1. AGENCY USE ONLY (*Leave Blank*)

2. REPORT DATE
January 29, 2006

3. REPORT TYPE AND DATES COVERED
Final Progress: April 30, 2000 - December 31, 2005

4. TITLE AND SUBTITLE
Solitonic Gateless Computing

5. FUNDING NUMBERS
DAAD19-00-1-0165

6. AUTHORS
George Stegeman (PI), Demetrios Christodoulides, Paul Prucnell, Greg Salamo, Mote Segev, & Ken Squier.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
College of Optics & Photonics: CREOL & FPCE, University of Central Florida
4000 Central Florida Blvd., Bldg. 53
Orlando, FL 32826-2700

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U. S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
41050.1-PH-MUR

11. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army Position, policy or decision, unless so designated by other documentation.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

A number of logic functions and mathematical operations were implemented in the laboratory based on soliton collisions in photorefractive media. In addition to the usual NAND and AND logic gates, soliton collisions do transfer information and two successive collisions can be made to mimic a unitary matrix or its inverse.

This program dictated and led developments in the field of soliton science and its applications. Its scientific impact was immense. It can be quantified in terms of the publications and presentations that flowed from it. Specifically, 98 of the total of 230 published papers in refereed journals were in the high impact factor letters journals Science, Nature, Physical Review Letters, Optics Letters, Optics Express and Applied Physics Letters. Finally there were 98 invited papers at international conferences, of which 4 were plenary. In addition there were 187 contributed conference presentations.

14. SUBJECT TERMS
solitons, photorefractive solitons, spatial solitons, applications of solitons, solitonic information transfer, solitonic computing, coupled waveguide arrays.

15. NUMBER OF PAGES
88

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-1
298-102

Table of Contents

Program Results

Executive Summary:

4) Statement of the problem studied

The goals of this program were to:

1. Provide proof-of-principle for the feasibility of using soliton collisions for computing
2. Investigate new fundamental concepts in soliton science to address #1.
3. Based on new science from #2, investigate new possible applications of solitons.
4. Investigate new related ideas.

5) Summary of the most import results

1. Soliton Computing

A number of logic functions and mathematical operations were implemented in the laboratory based on soliton collisions in photorefractive media. In addition to the usual NAND and AND logic gates, soliton collisions do transfer information and two successive collisions can be made to mimic a unitary matrix or its inverse.

Proof-of-principle investigations demonstrated that Manakov vector soliton-based computing is Turing Universal: any computation can be implemented in a system of colliding solitons. Furthermore, because these devices are based on a reversible physics, such a computing system would not generate waste heat in the collisions that implement its bit-level operations. Our comparative analysis pre-supposed a performance target of one Peta FLOPS, and compared the efficiency of implementations in solitonic and standard silicon VLSI technologies. While we have demonstrated a clear proof-of-principle for soliton based optical computing functions, electronics has advanced in speed and power requirements in the last six years and we recognize that there are power requirements that still need to be addressed in the solitonic case.

.

2. A plethora of new solitons and soliton phenomena were discovered in the course of this program. In continuous and discrete media, the concept that solitons need coherence was shattered and a variety of new solitons were reported including random phase solitons. Solitons with unique properties were demonstrated in semiconductor optical amplifiers at 10mW power levels. But by far the most interesting results were obtained in discrete systems both for single peaked and vortex solitons. Because the diffraction in such systems can be either normal *or* anomalous many new types of solitons were obtained in photorefractive, Kerr and quadratic nonlinear media. In addition, solitons in multiple bands were observed and collided. Parallel studies of filamentation indicated that there were regions of operation in which filamentation *did not* occur. Another highlight was the Brillouin zone spectroscopy by which the Fourier representation of the Brillouin zone can be mapped out on a single experiment. The richest results by far occurred in this basic science part of the program.

3. A number of new device concepts emerged from the basic soliton physics studies in 2.

(1) Since the output of the discrete arrays is spatially digital, a digital beam scanner was demonstrated.
(2) Furthermore, it was proposed that an all-optical 2D router could be implemented based on collisions between highly localized “blocker” solitons and beams traveling in diffraction free directions, or weakly localized solitons. The basic concepts were verified in 1D arrays with the incoherent interaction being the most attractive.
(3) One of the most interesting outcomes has been the development of an understanding of nano optical waveguides and their potential benefits to Army needs.

4. Fabrication of an important nonlinear material, namely quantum dots, was initiated and significant progress made. Key results such as control of quantum dot topology were achieved. In a separate development, digital operation of SOAs was demonstrated as triggerable memory elements.

This program dictated and led developments in the field of soliton science and its applications. Its scientific impact was immense. It can be quantified in terms of the publications and presentations that flowed from it. Specifically, 98 of the total of 230 published papers in refereed journals were in the high impact factor letters journals Science, Nature, Physical Review Letters, Optics Letters, Optics Express and Applied Physics Letters. Finally there were 98 invited papers at international conferences, of which 4 were plenary. In addition there were 187 contributed conference presentations.

Under sponsorship of this MURI program there were 16 PhDs awarded who are now in the workforce, 4 MScs and 11 undergraduates were introduced to research. Finally, there were a total of 11 senior personnel which include post-doctoral fellows, research associates, visiting faculty etc.

Squier - Summary Report on Soliton Computing

4.1 Logic and General Computation

This project began by asking the basic question, Can colliding solitons be used to implement general computation? The work done on colliding Manakov vector solitons developed a collection of digital devices (NAND gates, fanout, and signal crossover) that taken together form a Boolean complete set. That is, using only these devices, one can implement any arbitrary Boolean circuit. These devices include logic level restoration and clocked state elements, thereby allowing unbounded cascading of devices and synchronous system design. With these elements in hand, we can state that Manakov vector soliton-based computing is Turing Universal: any computation can be implemented in a system of colliding solitons. Indeed, any conventional computing machinery organization can be implemented this way. Furthermore, because these devices are based on a reversible physics, such a computing system would not generate waste heat in the collisions that implement its bit-level operations.

These results established that systems of colliding optical solitons have no inherent limitation restricting their ability to implement computing machinery. However, can colliding solitons be used efficiently to implement computation? For a first approximation, efficiency is in terms of processing speed, power consumption, and material resources measured in area of nonlinear optical propagation media. Of course, optimal efficiency depends on the degree to which a computation makes optimal use of the state transformations embodied in soliton collisions. It may be that the digital logic devices described above are substantially sub-optimal, and some other way of employing soliton collisions is more effective. Naturally, if some application algorithm were known to optimally match the characteristics of a system of colliding solitons, implementing that algorithm would yield the system's efficiency.

But even without such a benchmark, one can bound computational effectiveness by using a comparative analysis that looks in parallel at another technology. Our comparative method pre-supposes a performance target of one Peta FLOPS, and compares the efficiency of implementations in solitonic and standard silicon VLSI technologies. Similar simplifying assumptions are used for both implementations, and the power and size requirements are compared. Since we do not know the most effective method of using soliton collisions, we look at a collision system without specifying the devices or system structure.

Estimates of the performance of the solitonic system's internal devices are based on the assumed computational complexity of a single collision. In the least restrictive model, we simply count the maximum number of collisions possible, and use an absolute upper bound on the complexity of the computational operation taking place in a single collision. By adding more restrictive and realistic assumptions, we progress from model to model establishing progressively more conservative performance bounds. The most restrictive model uses a simplification of an implementation of a floating-point unit in digital logic, which is replicated as needed to reach the performance target. Throughout the analysis, the precise nature of the computation is left unspecified, but it is assumed there is always sufficient instruction-level parallelism available to sustain any computational units at full speed. There is no accommodation for such things as pipeline registers, branching hazards, data dependencies, or register conflicts, and there are no resources devoted to system control functions or instruction flow.

In general, we consider a collision system with *n* spatial 2-component Manakov vector solitons entering and exiting a collision system (see Figure 1). The collisions internally implement a computation with the data inputs encoded in the states of the input solitons and the system's output encoded in the states of the output solitons. Not every input soliton necessarily carries input data, some may be needed to supply non-data inputs to computational collision devices. Likewise, not every output soliton carries output information, some may carry away garbage information. But, all computation is internal to the optical medium and is in the form of soliton collisions, and there are no soliton sources internal to the medium.

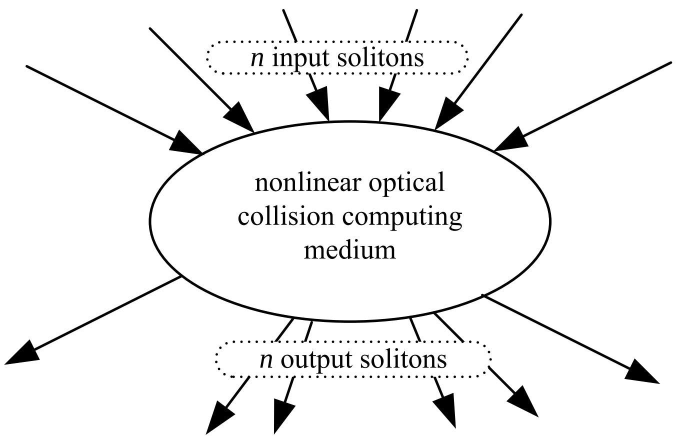


Figure 1

A collision system with *n* input solitons and *n* output solitons. There are no internal soliton sources. All computation is implemented within the soliton collisions inside the optical medium.

The maximum number of collisions occur if all the solitons are co-planar. Each soliton is one micron wide, with two micron separation between non-colliding solitons. For a typical collision angle of about 1°, the beam crossing distance is about 100 um and thus the time for one soliton to cross another soliton's path is about 0.5 ps (see Figure 2). Assuming a minimum separation between collisions of two beam widths, the distance between collisions is then three times the collision length, or about 300 um. The total area assigned to a collision accounts for a 2-um separation distance between solitons paths. A collision's delay is then just the propagation time across this minimum separation plus the beam crossing time. Layout and signal routing overhead is accounted for by using efficiency factors for VLSI. This and other modeling parameters come from the International Technology Roadmap for Semiconductors (ITRS). Characteristics for our VLSI model are estimated using the ITRS hp90 node, which is current technology with a feature size of 90nm.

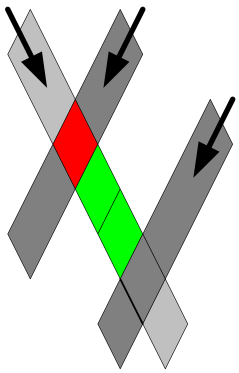


Figure 2

Three colliding solitons. The red area is a collision, the green areas are associated with that collision. Total area charged to each collision is three times the sum of the red and green areas. Delay time charged to the collision is the propagation time from collision to collision, which is three times the soliton crossing time.

Using these basic parameters, we implemented a model of a 64-bit adder/multiplier unit in VLSI and then converted to equivalents in the digital solitonic model (see Figure 3). For instance, while the VLSI design was not logic gate based, we used the ITRS mean of four transistors per logic gate, and converted the VLSI transistor count to an equivalent number of solitonic logic gates. The design was fully pipelined in a manner that is not practically possible, but conforms to modeling assumptions made for optical logic in the literature.

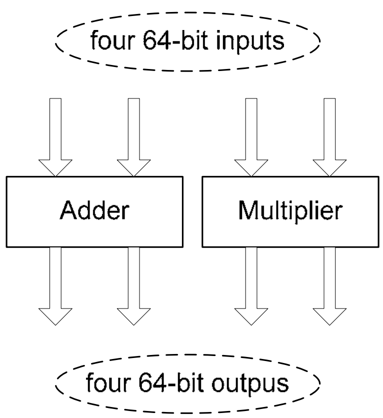


Figure 3

A pipelined, parallel, floating-point processing unit. Units are replicated as needed to attain the performance goal.

That is, without using pipeline registers, the unit can receive new data inputs after waiting only a nominal delay. The delay for VLSI model is based on the delay of a fanout-of-four (FO4) inverter. Six FO4 delays is chosen as that is an apparent limit on delay for the fastest pipeline design possible. Being more generous in the solitonic model, we use the delay of two basic pseudo-logic gates, based on the fact that any logic function can be implemented in two-layer logic if one ignores fanout. These gates, which we call Steiglitz-Rand gates (SR gates), are a composite of Steiglitz's NAND gate and Rand'

NAND gate, using the least restrictive assumptions in both cases. That is, we combine the best performance and efficiency features from known, solitonic digital logic devices without regard for the existence of any logic device having such a mix of characteristics. While not an actual logic gate, this pseudo-logic gate models a cascadable, signal-restoring logic with the least delay and fewest non-data inputs. In general, only the raw computing power based on device count is considered, and only optimistic assumptions for solitonic computing systems are used.

Technology	**VLSI**	**Solitonic-digital 1**	**Solitonic-digital 2**
Feature Size (um)	90 nm	1000 nm	100 nm
Soliton power		10 mW	25 uW
Total Area	30 cm^2	1 m^2	23 cm^2
Total Power	1 kW	5 MW	1.5 kW

Table 1

Comparison of silicon-based versus solitonic-based 1-Peta FLOPS, 64-bit floating point compute engines.

The results are shown in Table 1 for implementations of a 1-Peta FLOPS compute engine based on these adder/multipliers. The sources for solitons that are not cascaded between logic gates in the "Solitonic-digital 1" model consume 10 mW each and produce 1-um solitons. To reach the breakeven point with VLSI, the "Solitonic-digital 2" model has 25 uW soliton sources producing 100 nm solitons.

It is important to note what this analysis does and does not do. We do not start with optical Boolean logic devices, build a computing machine, and then measure its performance. Rather, we first design a hypothetical model of a VLSI system that consumes the least resources and has the best performance. The model serves to identify the minimum resources required for a system with the target performance. Simplifying assumptions are always in favor of optimistic efficiency and speed over realistic possibilities. This gives a lower bound on required resources with an upper bound on performance. The equivalent optical model is then constructed using an optimistic bit-operations-per-soliton-collision factor. This conversion factor is derived for the digital solitonic model using the SR gate. Both models then are used to produce area and power requirements based on current practice for VLSI and hypothetical bounds for solitonic systems.

The result is a picture of what kind of resources are required to achieve a given level of performance. The picture is grossly over-optimistic. But, it approximates real world expectations to the degree that actual system design, efficiency, and performance parameters have been preserved in the modeling. So, it presents a picture of solitonic performance and efficiency that is relatively easy to understand since it gives parameters of a vaguely realistic computing machine. The comparative analysis also provides a check on the mismatch between reality and the models. Clearly, no one would expect to produce a 1-Peta FLOPS adder/multiplier using only ten 300 mm^2 silicon chips. However, the comparison between the two technologies shows what kind of solitonic power and area efficiencies would be needed to make solitonic systems competitive for computing, under the assumption of binary digital processing.

Salamo – Arkansas – Summary Report

I. Solitons for Computing

A. Basic Science: During this MURI we experimentally demonstrated second-band modulation instability (MI) in a self-focusing waveguide array, obtained by exciting modes at the edge of the first Brillouin zone. This observation was directly compared with first band MI at the zone edge by switching to a defocusing nonlinearity. In both cases, the nonlinearity pushes the propagation constant off the linear bands, i.e. these nonlinear modes reside within a band gap of the transmission spectrum. That is, we have demonstrated lattice MI in photonic band gaps. Moreover, the observations are unique to periodic systems and do not occur in homogeneous media. We also observed second-band MI, the corresponding underlying theory, and distinguish the observed features from first-band MI and MI in homogeneous media. For the results in Figure 1, with intensity ratios I = 0.1 and 0.25, the experimental MI period corresponds to spatial momentum θ = 0.56 and θ = 0.78, respectively, in good agreement with the corresponding theoretical values θ = 0.52 and θ = 0.80. We also note that, similar to band 1, the MI gain and spatial frequency for band 2 increase with higher intensity.

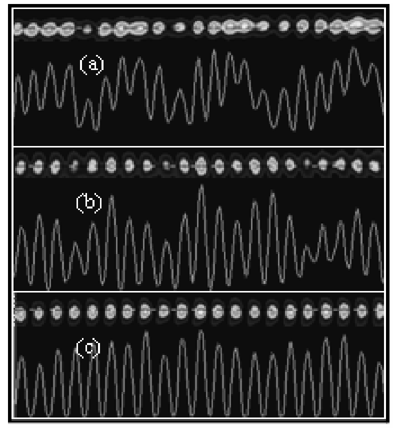


FIG.. Observation of lattice MI for a defocusing 1D array for (a) I = 0.1 and (b) I = 0.25, and (c) when the F-B mode located at the edge of band-2 is

B. Applied Science: One of the principal goals of this MURI was to use soliton collisions in an efficient way to do computation in a flexible manner. It was clear, theoretically and experimentally, that soliton collisions were a viable way to transfer information using vector solitons.

A vector soliton is a light beam composed of two independent components (A,B). During this MURI multiple collisions between vector solitons can be used to develop a Matrix Algebra.

In particular, we have demonstrated that two vector solitons can act as either a unity matrix that gives back the same vector after the matrix two collisions or the inverse matrix that reverse the A and B components. In the figure below we show that the incoming vector is made of A and B components of ratio A1/B1 = 0.49 and that the Matrix operation reverses the two components so that the ratio B1/A1 = 0.49. Of course, these operations conserve the magnitude of each vector so that A1 + B1 remains constant.

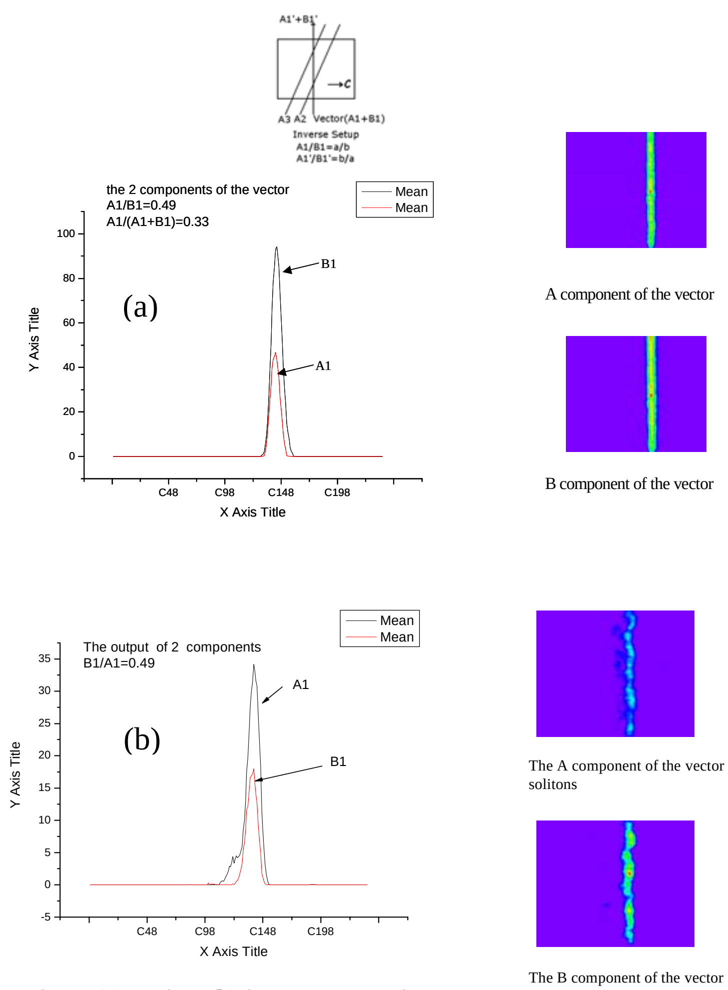


Fig.1. (a) Unity; (b) inverse operations

II. Quantum-Dot 3D Lattices for Enhanced Nonlinear Optical Soliton Interactions

A. Basic Science: The quest for computing concepts requires new approaches to material growth as well as new materials systems. During this MURI we have developed proficiency in molecular beam epitaxy (MBE), electron microscopy, and optical probe techniques which resulted in our published success in the fabrication and understanding of the behavior of self-assembled nano structures. Building on this early foundation during the first two years of the MURI, we have been advancing the science and tailoring the behavior of organized arrays of nanostructures. These advances provide the basis for crafting new photonic lattices with enhanced nonlinear behavior. Our goal of the MURI was to refine our skills in MBE to yield beautifully ordered 2D and 3D arrays of quantum dots, wires, and rings (noted in *Science*). Achieving this control over growth is now yielding material that gives new insight into the collective interactions between individual units and provides the basis to tailor a number of remarkable properties of 3D arrays: geometry dependent excited state lifetimes; tailored refraction and dispersion, and enhanced nonlinear optical coefficients.

As mentioned during the first two years of the MURI we used our MBE and *in-situ* STM and explored the nature of the size, shape, density, aspect ratio and volume of III-V semiconductor 3-D self-assembled islands. For example, our data for 3-D InAs islands on a GaAs substrate revealed for the first time the structural details of two different shaped islands. These pictures (Fig. 1) beautifully demonstrate the power of STM to reveal shape and size of quantum dot structures.

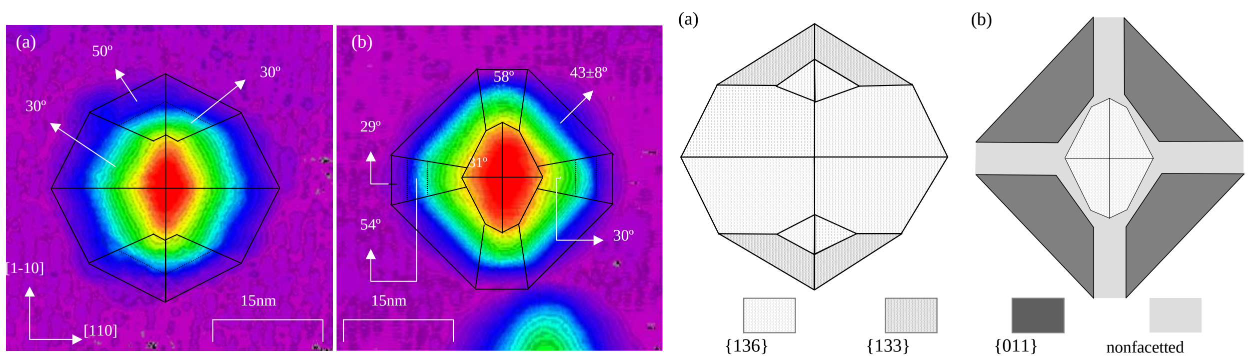


Fig. 1. STM picture and structure for two different dot shapes observed

More recently, however, we have explored their collective behavior. *Periodic* nanostructure arrays are desired for two reasons. First, they are much more uniform, which greatly improves their efficiency as lasers, detectors, memory systems, and nonlinear optical devices. Second, the collective properties of these arrays, such as their index of refraction, their polarizability, or their band structure depend upon their spacing, degree of interaction, defects, characteristic single electron energies, etc. While we are well aware of the collective behavior of solids, we have a new playing field to study and engineer "collective behavior". Shown in Fig. 2 is the x-ray diffraction pattern of 2D lattices of QDs. The peaks in the x-ray pattern tell us that we have an array that mirrors a typical crystal. As a result, we can expect that by nano-managing the structure of an organized array of synthetic units we can create systems in which we have control of their optical and electronic properties, even tailoring them to regimes not found in nature. For example, we are creating media with abnormally large or even negative indices of refraction or nonlinear optical photonic lattices that can dramatically change their reflectivity with an applied electric field or increasing optical intensity. Such "material by design" control would open a new era in applications ranging from improving nonlinear coefficients to optical computation that rival their electronic counterparts.

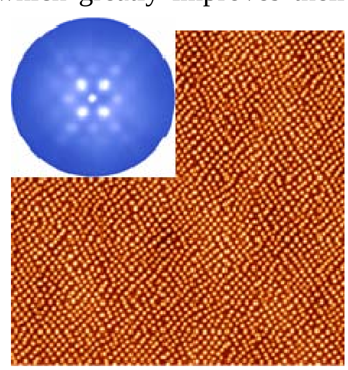


Fig. 2. An organized QD 2D array. The insert is an x-ray pattern that reveals the array periodicity. QD size is 20 to 30 nm.

In addition to 2D quantum dot nanostructures we have developed beautiful long chains of quantum dots that were highlighted in Science. These chains are amazingly over five microns long and have improved homogeneity when compared to the growth of randomly order dots (Fig. 3 (a)). These arrays already show interesting organizational as well as optical and transport behavior and offer the interesting opportunity to explore dots chains as electrical nano-interconnects. They are fabricated by layering quantum dots as seen in the TEM picture below (Fig. 3 (b)). The picture gives atomic resolution so that we can also measure the quantum dot facets (see Phy Rev B 69, 233312 (2004); APL 85, 5031 (2004); APL 84, 1931 (2004); APL 84, 4681 (2004)).Using our experience in coherent pulse propagation and quantum optics to design and measure dot arrays with tailored absorption and dispersion properties and even nonlinear coefficients. Moreover, using electromagnetic induced transparency (EIT) technology we will be able to selectively excite different regions or clusters of nanostructures creating dynamic interference effects that can be used to control the magnitude of the optical nonlinearity.

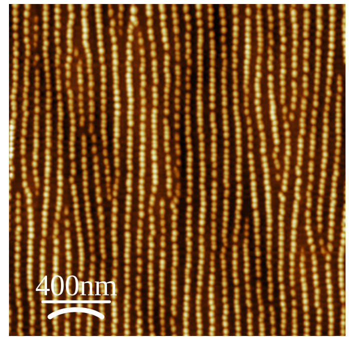


Fig 3(a).1D array of GaAs/InGaAs QDs

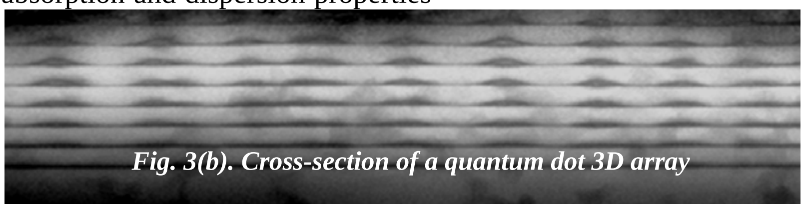


Fig. 3(b). Cross-section of a quantum dot 3D array

In this MURI we have also worked on semiconductor ring structures as small as 40nm across will be fabricated via self-assembly (Fig. 3 (c)). Ring structures differ from dots in that a classical point charge on a ring always has a dipole moment of fixed magnitude, although of arbitrary direction. Theory indicates that nano ring arrays should therefore undergo a phase transition from isotropic to anti-ferroelectric ordering as their interactions are increased. The point here is that it may be possible to tune ring geometries and produce structures with anisotropic polarizabilities and larger nonlinear coefficients. Such materials may have applications for switching optical solitons.

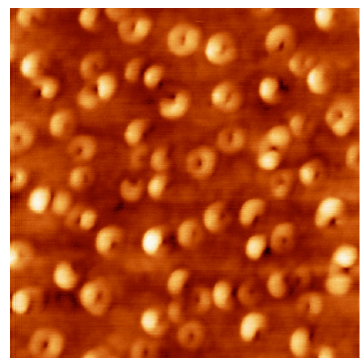


Fig. 3 (c) Arrays of GaAs/AlGaAs QRs

B. Applied Science: Finally, we have just started to grow ferroelectric nanostructures ranging from slabs, to rods to dots. The anticipated benefit hinges on whether the phase transitions and multi-stable states still exist in low-dimensional structures. This question is the subject of much contention and long-standing interest for understanding and revealing collective interactions. With many basic questions to answer and significant potential application, there are tantalizing opportunities for theory-experiment to push the state-of-the-art. The precise effects of the substrate, growth orientation, surface termination and thickness on the ferroelectric and ferromagnetic properties of nanodot arrays are also not clear. What will be their linear and nonlinear optical character and can they be enhanced? We have the unique opportunity to uncover the nature of nanoferroelectrics and increase their potential for application. In this MURI we have already reported (Fig.4) enhanced nonlinearity in our nanostructure $Ba_{0.6}Sr_{0.4}TiO_3$ grown films.

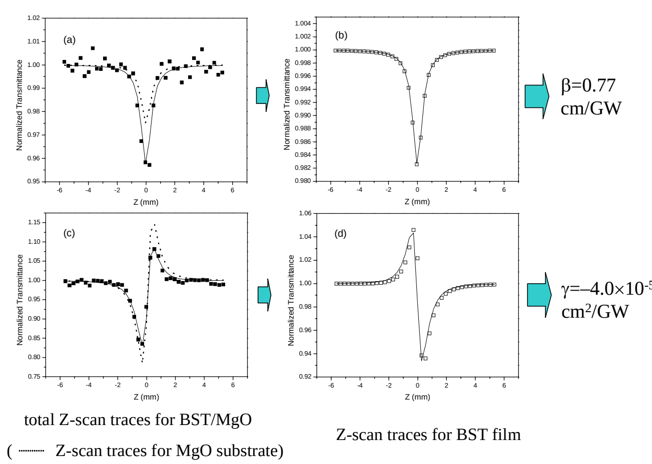


Fig. 4 Z-scan Measurements of $Ba_{0.6}Sr_{0.4}TiO_3$ film on MgO at the wavelength of 395 nm

Summary Report: Synopsis of MURI activities
Christodoulides-University of Central Florida

During this MURI, my group has been engaged in theoretical and modeling activities concerning soliton interactions. In particular we have investigated the possibility of utilizing discrete solitons in waveguide arrays and lattices for all-optical switching and routing applications. This activity was carried out in very close collaboration with the experimental groups involved in this MURI. In what follows we highlight some of the main thrusts of these activities.

Solitons for signal processing applications:

1. Navigating discrete solitons in two-dimensional nonlinear waveguide array networks:

Among the most important functions of a photonic network is to route information from a particular point of origin A to its final destination port Z. In such optical systems it is often highly desirable that routing is accomplished all-optically so as to avoid unnecessary electro-optic conversion. If for example data is re-directed by a space-switching matrix, it is also crucial that this process occurs with minimum diffraction induced cross-talk or losses among nodes. Nonlinearity can offer a promising solution to this problem since, under appropriate conditions, is known to balance diffraction effects. In fact, in nonlinear waveguide arrays (which can serve as the network nodes) a self-trapped entity is possible, better known as a discrete soliton (DS). By their very nature, discrete solitons represent collective excitations of the periodic lattice as a whole and they are the outcome of the balance between nonlinearity and linear coupling or discrete diffraction effects. Lately, optical DS were successfully observed in nonlinear AlGaAs waveguide arrays (by George Stegeman and Yaron Silberberg). As noted in several studies, the discrete character of these self-trapped states can lead to a host of new effects that have no counterpart whatsoever in the continuous/bulk regime.

In a series of papers, we have shown that DS in two-dimensional nonlinear waveguide array networks can provide a rich environment for all-optical data processing applications (PRL 87, pp. 233901, 2001). More specifically we have demonstrated that this family of solitons can be employed to realize *intelligent functional operations* such as routing, blocking, logic functions, time-gating etc. These DS can be *navigated* anywhere in the network along pre-assigned array pathways which act like “soliton wires”. Even more importantly, DS can be routed at array intersections using vector/incoherent interactions with other discrete solitons. In essence, these intersections behave as DS *switching junctions*.

Figure 1(a) depicts a nonlinear array network involving consecutive bends. Light in this array propagates along the *z*-axis and is confined in the transverse x-y plane. The waveguide cross-sections are shown in green. A discrete soliton *S*, the field profile of which is shown in red, is set in motion in this system. This is done by appropriately chirping (spatially) or tilting the soliton beam with respect to the *z*-axis. In order to investigate the effects of bends on the behavior of DS, we have numerically simulated the process. Interestingly enough we have found that DS can successfully negotiate a sequence of bends with very little radiation/reflection losses. The DS follows the pre-assigned path (as shown schematically in Fig. 1(a)) and remains essentially invariant during propagation.

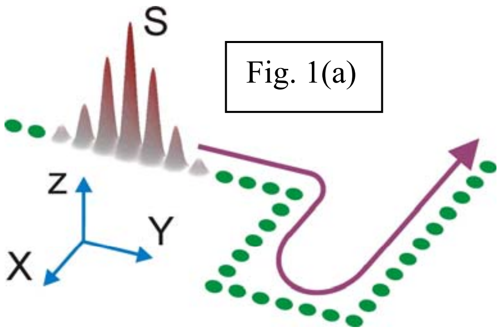


Fig. 1(a)

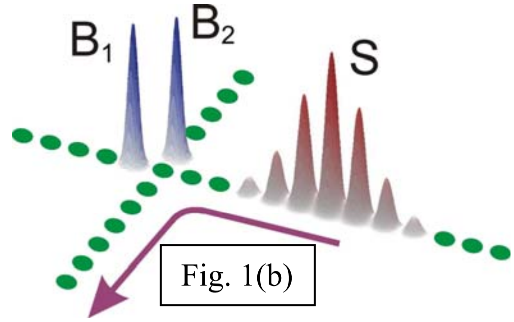
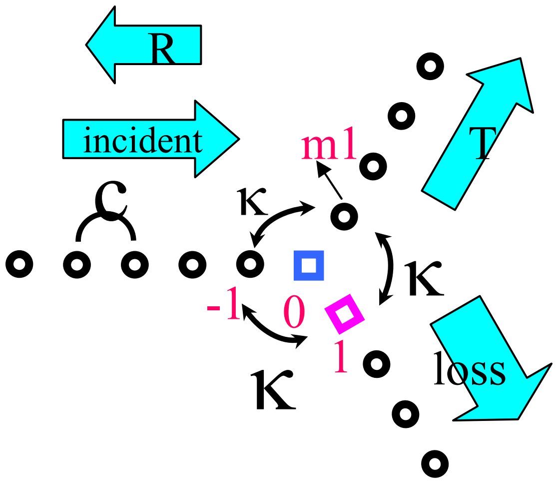


Fig. 1(b)

Such systems can also be used to realize logic operations. Figure 1(b) illustrates an *X - switching junction*. This junction employs two different DS families, the so-called "signals" and "blockers" denoted by *S* and *B*, respectively. Signals are moderately confined DS whereas blockers (depicted in blue) are strongly confined occupying effectively one site. Unlike signals which are highly mobile, blockers, states deeply located in the *spatial photonic bandgap* of the waveguide lattice, tend to retain their position after a collision event. In the junction shown, the blockers B_1 and B_2 interact "incoherently" with *S*. This is possible by using different colors or polarizations in a nonlinear material. As the figure schematically shows, the signal soliton *S* is routed towards the lower branch, due to the presence of the two blockers at the entries of the respective pathways. This again happens with very little loss (below 4% per junction). It is important to note that had one of the two blockers not been present at the junction, the signal DS would have totally disintegrated into transmitted and reflected waves. Thus in essence, the junction operates as an AND gate. The design of such DS switching junctions was reported in Optics Letters, vol. 26, pp. 1978 (2001). Similarly, other operations, such as time-gating and memory functions, can also be implemented in these systems.

2. **Minimizing bending losses in discrete soliton networks:**
Bends in discrete soliton networks are certainly essential elements in such array systems. In general, DSs propagating along a bend tend to lose power because of reflections. Depending on the bend angle, these losses can be considerable. This is especially problematic if bends are to be used in cascade. Reducing bending losses in DS networks is thus an issue of importance. In this period we have shown (Optics Letters, vol. 26, pp. 1876) that, by appropriate design, reflection losses occurring along sharp bends in two dimensional DS networks can be almost eliminated. Analysis indicates that this can be accomplished by modification of the guiding properties of the corner waveguide. Our analytical results were found to be in excellent agreement with numerical simulations. The design of these corners was carried out by employing the corresponding unfolded photonic circuit of the bend. Similarly, the switching efficiency at T and X-junctions can be optimized by engineering the waveguides at the vicinity of the switching junction as shown in the figure below.



The performance of switching junctions in two-dimensional discrete-soliton networks was analyzed theoretically by coupled-mode theory. Our analysis can be used for the design of routing junctions with specified operational characteristics. Appropriately engineering the intersection site can further improve the switching efficiency of these junctions up to 99%. Our analytical results were verified again by numerical simulations.

3. **Discrete temporal solitons along a chain of nonlinear coupled microcavities embedded in photonic crystals:**
We have shown that spatiotemporal discrete solitons are possible in nonlinear photonic crystal structures. Analysis indicates that these states can propagate undistorted along a series of coupled resonators or defects by balancing the effects of discrete lattice dispersion with material nonlinearity. In principle, these self-localized entities are capable of exhibiting very low velocities depending on the coupling coefficient among successive microcavities. This class of solitons can follow any pre-assigned path in a three-dimensional environment. These results have been reported in Optics Letters, vol. 27, pp. 568 (2002).

4. **Discrete solitons in nonlinear zigzag optical waveguide arrays:**
We have demonstrated that the discrete diffraction properties of a nonlinear zigzag waveguide array can be significantly modified by exploiting the topological arrangement of the lattice itself. This introduces long-range interactions which in turn affect the lattice dispersion relation within the Brillouin zone. As a result of this band alteration we have demonstrated that new families of discrete solitons are possible which are stable over a wide range of parameters. For more information see, Phys. Rev. E, vol. 65, pp. 056607 (2002).

5. Discrete Ginzburg-Landau solitons
The complex Ginzburg-Landau (GL) equation is known to play a ubiquitous role in science. This equation is encountered in several diverse branches of physics, such as, for example, in superconductivity and superfluidity, nonequilibrium fluid dynamics and chemical systems, nonlinear optics, and in Bose-Einstein condensates. In optics, the discretized version of the Ginzburg-Landau equation is often used to model semiconductor laser arrays or arrays of highly nonlinear semiconductor amplifiers

(SOAs). We have demonstrated (physical Review E, vol. 67, pp. 026606, 2003) that discrete solitons are possible in Ginzburg-Landau lattices. More specifically, we have shown that this system exhibits unique complex dispersion properties associated with a Brillouin zone. As a result, the discrete dispersion /diffraction behavior of a GL lattice differs substantially from that encountered in conservative arrays. In general, two new types of discrete GL solitons can exist under the same conditions. These solutions are located either at the base or at the edge of the Brillouin zone and bifurcate at different values of the linear gain. As a result of discreteness, we find that this system exhibits features that have no counterpart whatsoever in either the continuous GL limit or in other conservative discrete models as in discrete nonlinear Schroedinger chains. These include, for example, on-site and intra-site bright DGL solitons that can both be stable as well as new bifurcation types that cannot be identified in the continuous case.

The original concept for the MURI was based on using collisions between multi-component solitons to perform computing and other signal processing functions. The ratio of the components changes in a deterministic way on collision thus leading to well-defined initial and final states which are interpreted as a mathematical operation.

To investigate this process this group investigated experimentally and theoretically:

(a) The properties of spatial solitons in Kerr, quadratic and amplifying media;
(b) Limitations on solitons due to anisotropy and modulational instability;
(c) Soliton collisions utilizing different types of solitons and their applications;
(d) Other unique related phenomena and their potential applications;

Only research highlights are summarized here. Details are in prior reports.

1. Quadratic Media

Quadratic spatial solitons (QSS) are multi-component (vector) solitons consisting of all of the frequency components coupled via the second order optical nonlinearity $\chi^{(2)}$ near a wavevector matching condition. A variety of wavevector matching techniques including Type I (birefringent) and quasi-phase-matching (QPM) by periodic poling of the nonlinearity were used, primarily in second harmonic generation (SHG) geometries.

1.1 Quadratic Solitons in Bulk Media

Two different media were utilized for QSS generation, both of which were non-critically phase-matched (NCPM). A key feature of NCPM is that the refractive index curves for the fundamental (FW) and harmonic (SH) were tangent to each other along crystal axes. Thus the angular bandwidth, i.e. the range of incident light angles for soliton generation was very large, very useful for applications. The measured bandwidth of the threshold for soliton generation versus incidence angle for Type I NCPM in $KNbO_3$ was 24 degrees. For QPM KTP is was about half this value, both being about two orders of magnitude larger than for Type II SHG.

The QSS consists of *in-phase* fundamental and harmonic components. This phase sensitivity makes the generation of QSS'es by injecting both field components too cumbersome to be practical. It was found that injecting just the fundamental and allowing the appropriate second harmonic to be generated over small distances led to well-formed solitons as shown in Figure 1(b). In principle, QSS'es can be generated with variable fundamental to harmonic field ratio, depending on the soliton power which would be ideal for exchange of the different field components during a collision. Unfortunately, using fundamental only excitation crystal optical anisotropy and/or small input beam ellipticity led to the generation of multiple solitons specifically oriented in space and with powers less than twice threshold, too limited to be useful for computing. This general limitation was found in both NCPM samples investigated.

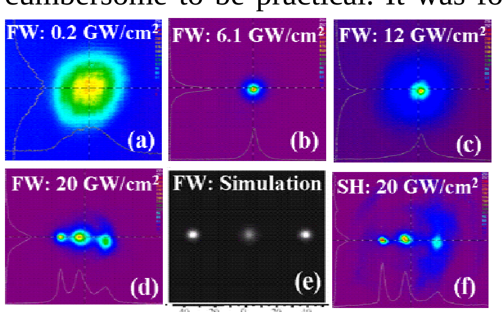


Fig. 1 (a) Diffracted low power fundamental beam. (b) QSS just above threshold. (c) Excess radiation emitted at twice threshold. (d) Fundamental and (f) harmonic emitted at three times threshold. (e) Simulation for cases in (d) and (e).

1.2 QSS in Slab Waveguides

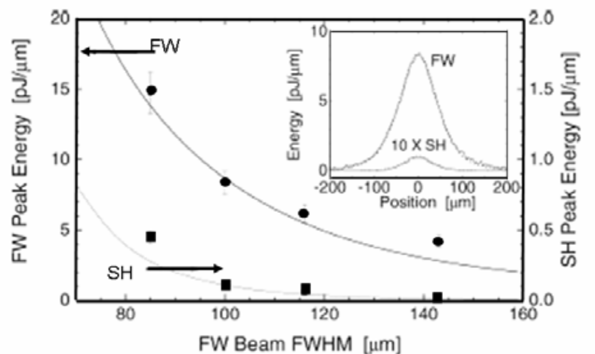


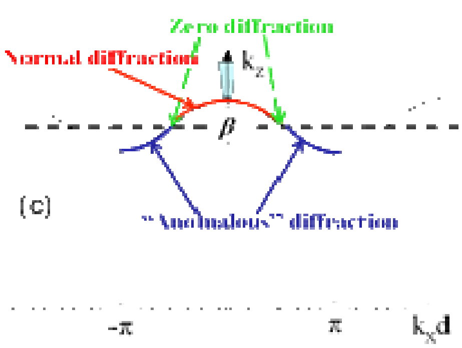
Fig. 2 Trade-off between the pulse energies in the FW and SH components of a 1D QSS and the full width half maximum for QPM $LiNbO_3$ slab waveguides at 1550nm for a 7.1π phase mismatch. In the inset is a typical set of intensity profiles.

In parallel, QSSes were also investigated in slab (1D) waveguides made by Ti:indiffusion using Type I and QPM phase-matching. Again it proved possible to generate high quality QSSes by injecting only the fundamental beam, but again multi-soliton generation occurred at high input powers.

The QPM samples were used to investigate for the first time the ratio of fundamental to harmonic power in a 1D QSS versus its spatial width for a fixed value of wavevector mismatch. The results are shown in Figure 2 and are in good agreement with theory.

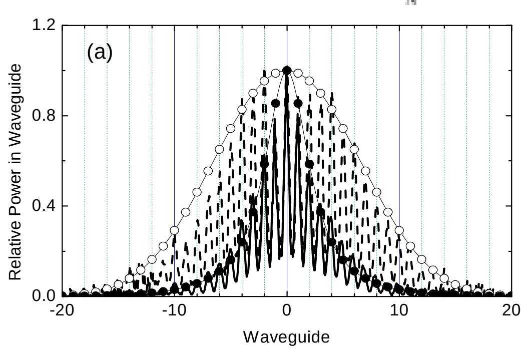
1.3 Discrete Quadratic Solitons : 1D

Arrays of channel waveguides fabricated in sufficiently close proximity that their fields overlap constitute a weakly coupled array known as a 1D discrete system. Light at the fundamental frequency "diffracts" throughout the array, i.e. spreads from input channels outwards through neighboring channels, due to coupling from one channel to another. The second harmonic light is too strongly confined to each channel to couple between them and appears in channels solely due to conversion from the fundamental present in them. When the media are nonlinear, discrete solitons can be generated in which self-trapping occurs over a discrete number of channels, one, two etc.



The linear dispersion relation was investigated. As predicted, regions of normal diffraction, anomalous diffraction separated by zero diffraction were found and verified experimentally. Such arrays will be useful for electro-optic beam deflectors.

Fig. 3 Discrete dispersion relation for the propagation wavevector k_z versus the relative phase between adjacent channels ($k_x d$).



We were able to observe for the first time both staggered (π phase shift between fields in adjacent channels) and unstaggered (in phase fields) discrete quadratic solitons. Shown in Fig. 4 is the unstaggered case and clearly the agreement between experiment and theory is excellent. This was also the case for the staggered solitons. Highly confined (single channel) solitons were also observed.

Fig. 4 Intensity profiles of the diffracted beam (open circles – calculated; dashed line – measured) and a discrete unstaggered soliton (solid circles – calculated; solid line measured).

1.4 Instabilities

It was predicted theoretically that noise on a wide beam in quadratically nonlinear media, either continuous or discrete, gives rise to filamentation. This limits the utility of quadratic solitons for computing or signal processing. This effect was investigated in both 1D slab waveguides and in 1D discrete arrays.

Shown in Fig. 5 is the evolution with increasing input power of a fundamental beam injected into a QPM Ti:indiffused $LiNbO_3$ slab waveguide. (a) shows diffraction at low input powers and collapse into a soliton. As the power is increased further, (b), side lobes appear in the pattern and, at the highest power, multiple peaks occur which change with each laser shot, the signature of noise-induced filamentation.

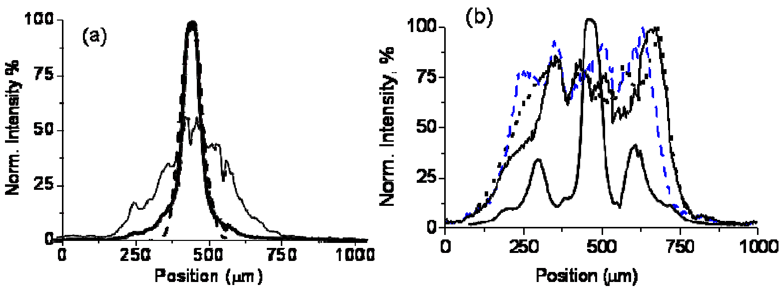


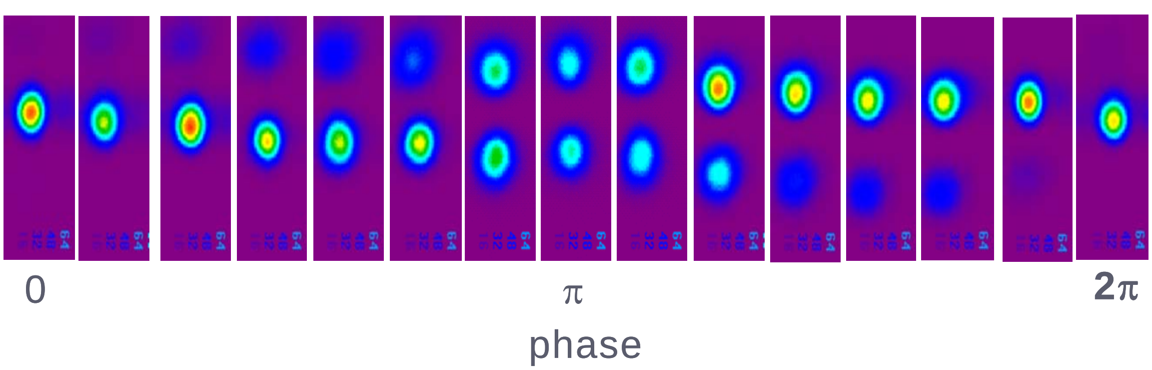
Fig. 5 FW profiles . (a) dashed line - 74μm input beam; dark line – diffracted beam; heavy dark line – 1D QSS. (b) 3-peaked line – output at twice soliton threshold power; other lines – irreproducible filamentation at 3 times threshold

Similar effects occurred in bulk samples in which case the irreproducible patterns occur in 2D. This was observed in the NCPM Type I $KNbO_3$ sample.

Modulational instability was also observed in the discrete arrays with results similar to those that will be discussed later for AlGaAs discrete arrays.

1.5 Collisions

The large angular bandwidth discussed previously in 1.1 for quadratic solitons in bulk non-critical phase matching (NCPM) geometries was ideal for the investigation of collisions between quadratic solitons. Collisions between two identical solitons in $KNbO_3$ were investigated in both coplanar and non-co-planar geometries. In the first the solitons were co-planar, launched at a relative angle of 0.17^0. The details of the collapse into a single soliton at zero phase angle, the repulsion at a phase angle of π, and the preferential energy exchange at intermediate angles are all clear in the images obtained at the output of the crystal. To within



5%, energy is conserved in the collision, as is the composition of fundamental versus harmonic. In the second geometry, the solitons propagate in planes 10μm apart with a "collision angle" of 0.9^0 when projected into a common plane. A third soliton was observed after collision over a range of relative phase angles. These results indicate that QSS collisions are unsuitable for applications where the relative phase may be ill-defined.

1.5 Related Phenomena and Applications

1.5.1 Switching

Three experiments on switching of beams were performed. The first relied on the multi-soliton generation phenomenon discussed previously. In brief summary, a small amount (1% intensity) in harmonic seeding caused the two subsidiary solitons in Figure 1 to disappear. This is one of the rare cases where a weak beam can control strong beams.

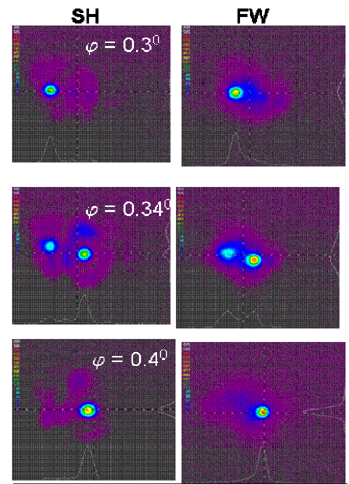


Fig. 8 Output FW and SH soliton components for different incidence angles on the interface.

The second case is a consequence of the fundamental and harmonic field components of the soliton being *in-phase*. When the poling pattern in PPKTP is shifted by half a period as shown in Figure 7, this introduces an effective barrier potential which can reflect a soliton. When the incidence angle is increased, a transition from reflection to transmission through the interface occurs. A similar transition occurs as the power is increased. This can be used for switching.

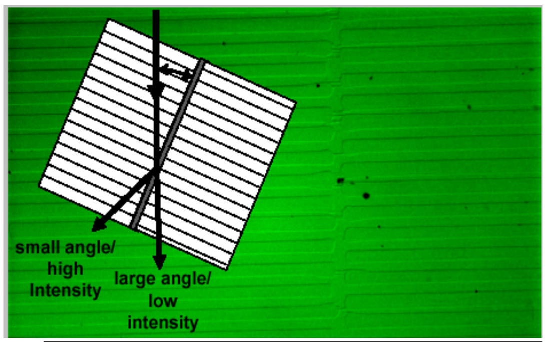


Fig. 7 Sample-light geometry.

The general idea for the third application is summarized in Figure 9. A strong, SH control beam (blue) was coupled into a selected channel of an array. An input signal beam traversed the array at the non-diffracting angle and interacted with the control beam to produce a deflected beam. For strong control beams, the input and output signal experienced gain in this parametric process. For input signals not exactly half the control frequency, the output was frequency shifted. Demonstrated was the generation of a frequency shifted output signal (“idler” at ~1554nm) from an input signal at ~1543.5nm. This can be used for frequency shifting in optical communications.

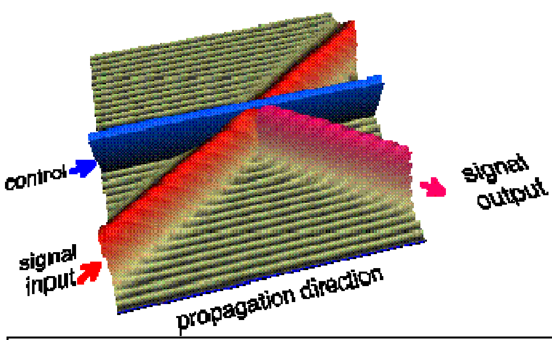


Fig. 9 Interaction geometry.

1.5.2 Discrete Talbot Effect

The Talbot effect in continuous media is well-known since the mid 1800s. A periodic pattern is reconstituted in space every integer multiple of the well-known Talbot distance. The discrete Talbot effect was first investigated theoretically. It was found that recurring patterns only occur for the excitation of every 1st, 2nd, 3rd, 4th and 6th channel. In continuous media there is no such restriction. In discrete media it is the different form (periodic) of the dispersion relation found there that is responsible. This prediction was confirmed in a series of low power experiments in PPLN arrays at 1550nm.

2. 1D Kerr Solitons in AlGaAs Below Half the Bandgap

Spatial solitons based on the Kerr effect exist in only 1D (slab waveguides) in continuous media. They were observed both as scalar and vector (Manakov, two orthogonally polarized components) in the 1990s and their properties are well-known.

2.1 Discrete Kerr Solitons

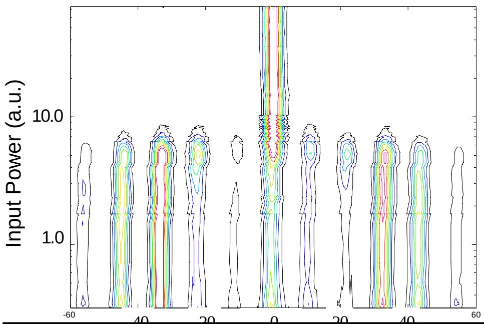


Fig. 10 Collapse of the output intensity from the AlGaAs array versus input power into the central channel.

The early pioneering work was extended to highly localized (essentially single channel) and vector (two polarization) discrete Kerr solitons.

The collapse of the discrete fields into a strongly localized (blocker) soliton with increasing input power into a single channel is shown in Figure 10. Despite the pulsed nature of the input fields, the collapse is strongly reminiscent of a first order phase transition. Similar results were obtained for the successful excitation of vector discrete Kerr solitons. This is very different from the gradual collapse observed in slab waveguides.

2.2 Collisions and Applications

The coherent collision between two 1D discrete Kerr solitons was investigated to determine its suitability for computing applications. At low input powers, each beam diffracts and interference effects similar to those of a phased array antenna occur with changes in relativephase. The output is spread typically over 4-5 channels. As the input power is increased, the output collapses into single channel solitons and varying the phase causes the output to jump from channel to channel. This is a digital beam scanner. At very high powers, the coupling between channels disappears.

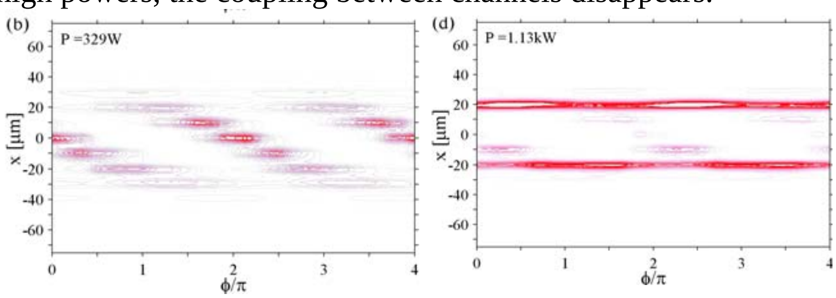


Fig. 11 (b) Output from array as a function of the relative phase between two discrete solitons showing phase-scanning of single solitons. (d) High power output.

A number of experiments relevant to routing in two dimensional arrays of channel waveguides were also performed. They involved a “blocker” (strongly localized single channel) soliton interacting with a beam traversing the array at the zero diffraction angle, i.e. the control beam does not spread. Three different cases were investigated: (1) co-polarized mutually coherent beams; (2) orthogonally polarized mutually coherent beams; and (3) orthogonally polarized mutually incoherent beams. The geometry and representative results for cases 2 and 3 in (b) and (c) are shown in Figure 12. Only for case (c) was the deflection of the blocker phase-independent and hence useful for routing. Note the deflection is digital. Finally, two successive control beams were demonstrated to move the blocker solitons successively by one channel each. This deflection is the basic operation of a router switch.

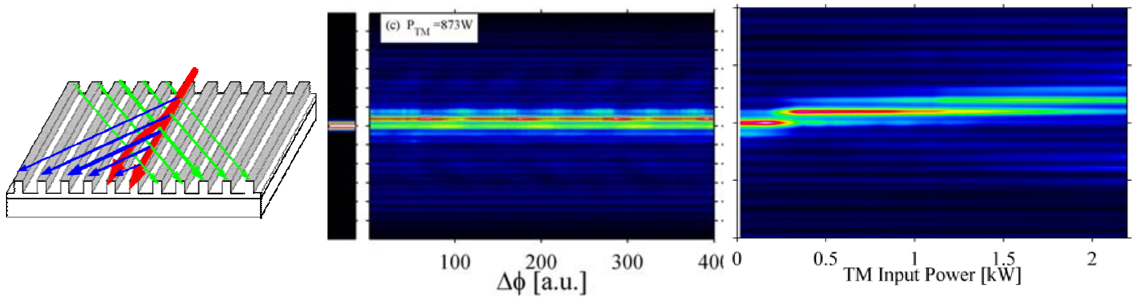


Fig. 12 (l.h.s.) Interaction geometry showing the blocker soliton (red), the control beam (green) and the partially reflected control beam (blue). (middle) The phase dependence of the TE polarized blocker deflection for case 2, TM power = 870W – incident blocker on the left. (c) Deflection of the blocker as a function of TM (control) power for the incoherent beams case 3 which is phase independent.

2.3 Filamentation (Modulational Instability)

The same mechanisms that lead to solitons, diffraction balancing self-focusing, also lead to the noise-induced break-up of a wide intense beam. This process was investigated in both a 1D slab and in a 1D array of coupled channel waveguides.

The more interesting case is the discrete array since over ½ the range of possible propagation directions($\pi/2>|k_x d|$) these two mechanisms lead to filamentation, and over the other half ($\pi>|k_x d|>\pi/2$) no filamentation (or bright solitons) should occur. This was predicted theoretically. The experimental results are shown below in Figure 13.

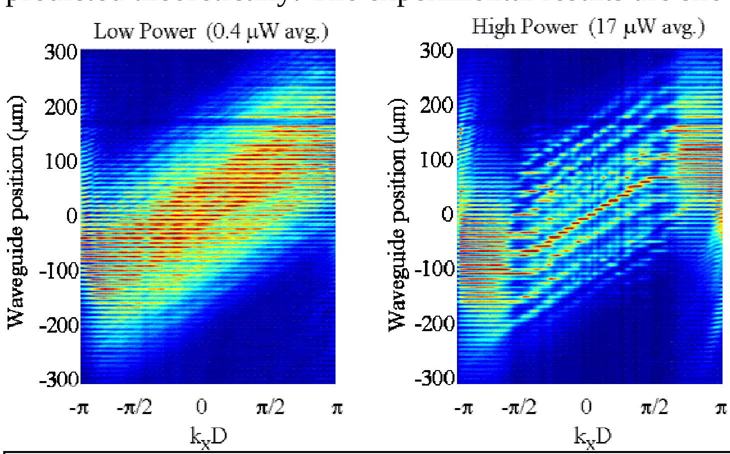


Fig. 13 Variation with input wavefront tilt (k_xD) of the beam at the output facet for two different input power levels, high and low. Note that the input wavefront tilt causes the beam to move across the array. The weak filamentation at low powers is caused by array imperfections. At high powers strong filamentation occurs for ($\pi/2>|k_x d|$ and no filamentation for $\pi>|k_x d|>\pi/2$.

As the low power input wavefront is tilted, the beam traverses the array at different angles. The striations are due to imperfections in the waveguides. At high powers these striations narrow into filaments, indicative of modulational instability gain. Note that, as predicted, there are regions in which filamentation does not (and cannot) occur. The gain coefficient was also measured by seeding the input beam with different periods.

3. Amplifying Media: Semiconductor Optical Amplifiers (SOAs)

3.1 Dissipative Solitons

"Zero parameter" dissipative spatial solitons were observed in AlGaAs semiconductor optical amplifiers (SOAs). Diffraction and nonlinearity are balanced, and simultaneously gain balances loss. For a specific gain value, there is only one soliton possible with a specific peak power and width, i.e. there is no power-width trade-off.

The zero parameter properties are verified in Figure 14. First, there is no transmission at the output if the input is below threshold, i.e. it is all absorbed. Above the threshold, the output (soliton) light intensity remains a constant, independent of the input. The striations were verified to be due to imperfections in the device since they were fixed in position when the beam was translated transversely across the sample. With fixed light input power, there is also a threshold gain for soliton generation and the output intensity increases with the gain. These properties are all in excellent agreement with theory. Note that these solitons have **10's mW** peak powers!!

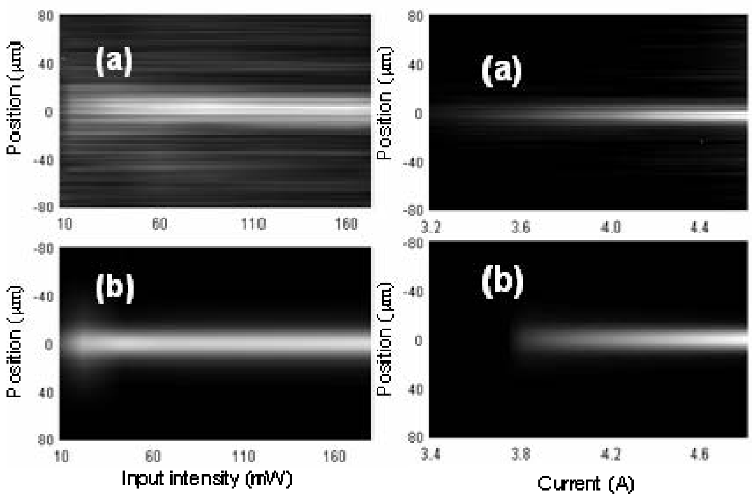


Fig. 14 Left-hand-side: The measured light intensity at the output versus the input light power, (a) experiment, (b) theory.
Right-hand-side: The measured output light intensity (fixed input intensity) versus the input current, (a) experiment, (b) theory.

Also investigated was whether two component, incoherently coupled solitons exist. Two cw light sources, TS at 943nm and LD (948nm) were simultaneously and collinearly injected into a current pumped InGaAs single quantum well SOA and the output of each beam was monitored as a function of input TS power. The results are shown in Figure 15. Clearly the two beams interact, exchange energy and form a coupled pair by the output. The beams are mutually trapped since neither beam diffracts. The results are in excellent agreement with simulations based on the equations previously used to predict dissipative solitons.

Detailed numerical simulations show that for very large propagation distances the power is all converted into one wavelength. For stability the zero parameter property requires that both the gain and the diffraction must be identical at the two wavelengths, otherwise one beam ends up with all of the input power. Note that the widths of the two beams maintain their sech-like shapes and their same width (self-similar beams) on propagation. Hence these coupled beams are not really "solitons". However, over the sample lengths involved, they are sufficiently locked together to be potentially useful for signal processing.

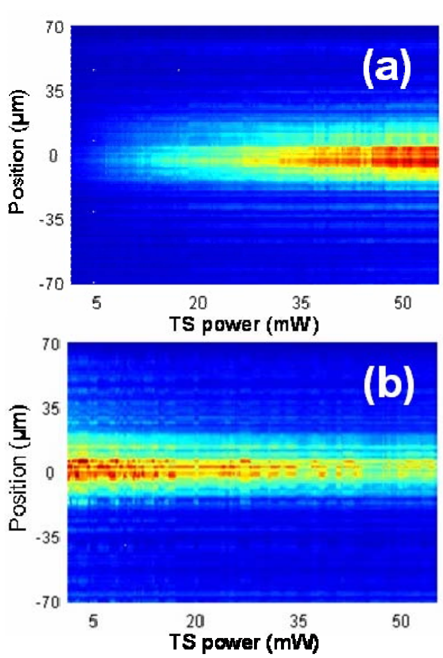
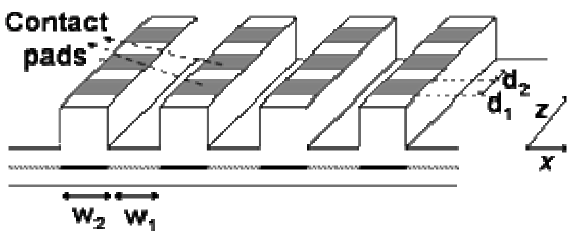


Fig. 15 Output of (a) the TS beam and (b) the LD beam as the TS power is increased.

It has been demonstrated that optical discrete solitons are possible in dissipative arrays or lattices. Such dissipative lattices can be implemented by using periodically patterned semiconductor optical amplifiers and absorbers. Unlike their continuous counterparts, this new



class of solitons exhibits several interesting characteristics because of discreteness. For example, these new solutions no longer belong to a zero parameter family and their nature dpends on their Floquet-Block band structure. Experiments are underway.

3.2 Instabilities

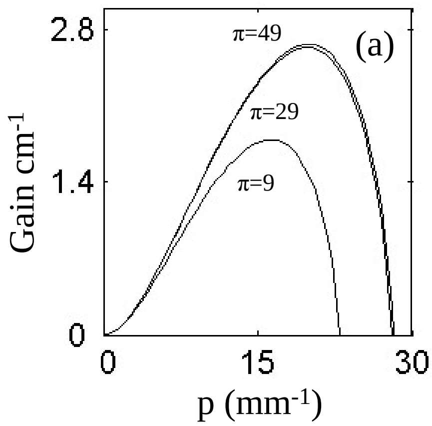


Fig. 17 MI gain versus noise periodicity at three different pump current levels π.

The theory of modulational instability (MI) was developed for dissipative, gain media under conditions appropriate to regions for which solitons have been observed previously. It was found that fluctuations in the phase and/or amplitude of the optical field or the carrier density can lead to filamentation.

The variation in the instability gain coefficient with the spatial frequency "p" of the noise resembles closely that reported previously for other soliton systems, as shown in Figure 17. There are, however, some interesting differences. For example, the gain saturates with increasing pumping current, a feature not found in any other MI system in the small signal limit. These calculations also yielded insight into regimes in which solitons with sub-10μm widths can be excited.

3.3 Collisions

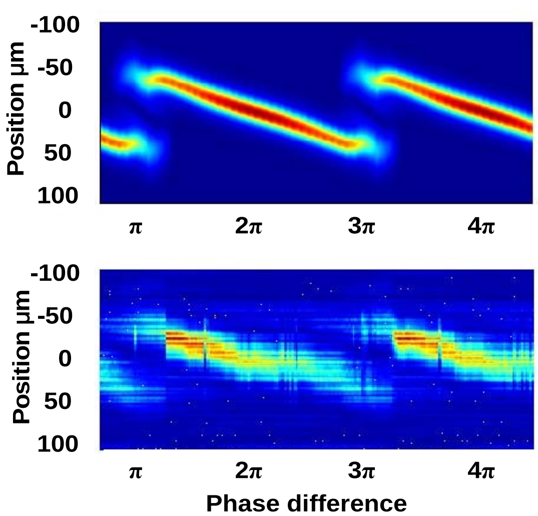
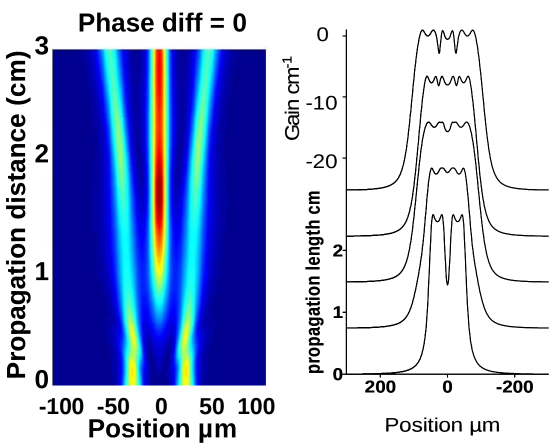


Fig. 18 Measured (lower) and calculated (upper) patterns at the output facet for two parallel solitons, 20μm wide for beam separations of 22 μms (optical fields overlap). Experimental results are a collage of experiments with variable relative phase.

The interactions between these solitons were measured or two different input separations. The results show that the interaction can be either local (fields overlap) or non-local (no field overlap). In the local case, Figure 18, the beam scanning with variable relative phase between the input solitons is very clean and the output always corresponded to a single soliton of the same power as the input power of each individual soliton. This is a direct consequence of the zero parameter nature of this type of soliton.

For the non-local interaction, the gain and index change accompanying each soliton has an effective width of ~50μms leading to a non-local interaction. Shown in Figure 19 is the evolution of both the calculated index and gain distribution due to the interaction and the optical fields. Note that a third maximum occurs in the index change which leads to and supports the generation of a third soliton. The initial separation can optimized



to give three, equal power solitons at the output. This third soliton has been observed in a soliton crossing interaction (not shown here).

Fig. 19 Calculated field intensity (left-hand-side) and evolution of refractive index change with distance (right-hand-side) for two input, in phase, solitons.

4. Related Phenomena: Switching in a Dual Core Photonic Crystal Fiber (PCF)

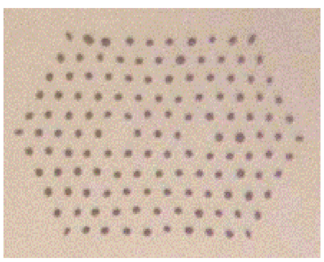


Fig. 20 Cross-section of a dual “defect core” photonic crystal fiber.

Via a collaboration with OFS, we have obtained a prototype directional coupler fabricated in a PCF, i.e. two parallel channel (defect core) device. A picture of the cross-section of the fibers is shown in Figure 20. Note the small asymmetry (larger hole) on the right hand side which introduces birefringence between the two cores in this prototype fiber and limits the transfer efficiency for this particular fiber. This fiber was cut to different lengths and the periodic power transfer distance between the two cores was measured to be ~4mm.

Power-dependent transfer the two cores is demonstrated in Figure 20. However, the plateau observed at high intensities is spurious because, as shown in Figure 20, the fraction of energy transmitted through both cores at 1550 nm decreases rapidly with increasing input. This energy is lost to other wavelengths due to multiple nonlinear optical phenomena.
control beam powers.

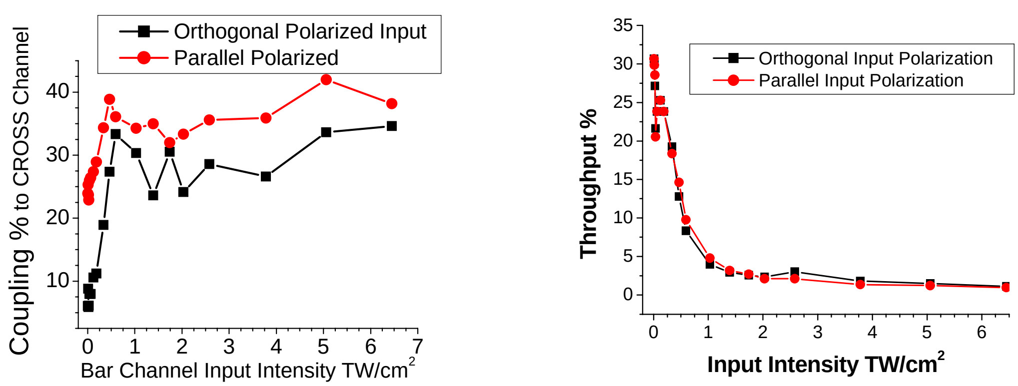


Fig. 20 Left-hand-side: Outputs from the crossover PCF core when the input core is excited and the input power is increased for light polarization parallel and perpendicular to the line joining the cores. Right-hand-side: The total throughput from both cores at 1550nm as a function of input intensity.

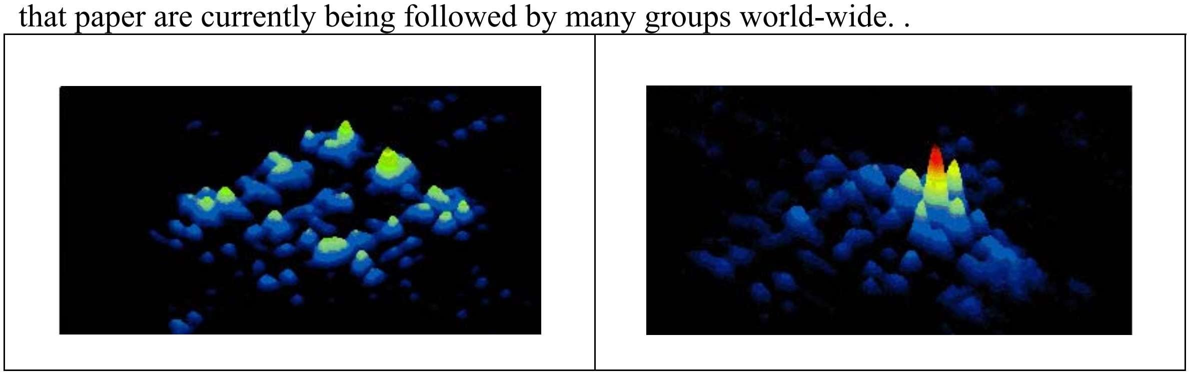
Research Highlights – Segev and Christodoulides

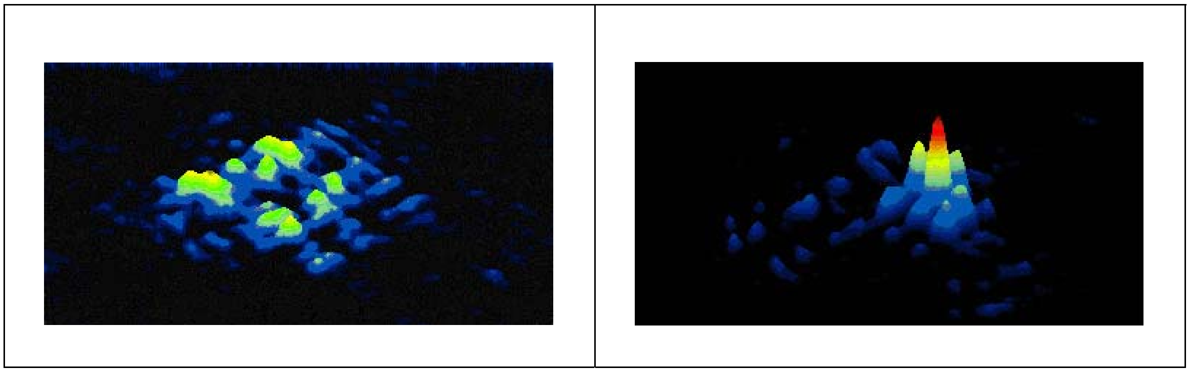
1. Solitons in periodic structures: Lattice ("Discrete") Solitons

1.1 Observation of two-dimensional lattice solitons

In March 2003, our team has made an important breakthrough, in demonstrating the first solitons in a two-dimensional nonlinear photonic lattice [Fleischer et al, **Nature**, vol. 422, pp. 147, 2003; *see also commentary about this work in the April issue of* **Physics Today**, 2003, *in the Physics Update section*]. This experiment was in fact the first soliton ever demonstrated in any 2D periodic structure in nature. We first demonstrated bright 2D lattice solitons in their simplest realization: in-phase solitons at the base of the first Brillouin zone. Then, we proceeded to demonstrate the first 2D spatial gap solitons (self-trapped "staggered" wavepackets arising from the edge of the first Brillouin zone in defocusing systems). The formation of the 2D nonlinear photonic lattice relied on an optical induction technique in which a 2D array of waveguides is induced in a nonlinear medium. The waveguide array is induced, in real time, in a photosensitive material by interfering two or more plane waves. A separate 'probe' beam is launched into the periodic waveguide array, where it exhibits discrete diffraction and, at a sufficiently high nonlinearity, forms a lattice soliton. For this system to work, it is essential that the waveguides are as uniform as possible, implying that the interference pattern (inducing the lattice) must not change in the propagation direction. For this to happen in the nonlinear medium, the interfering waves themselves should not be affected by the nonlinearity. At the same time, the probe (soliton-forming) beam must experience the highest possible nonlinearity. A photorefractive material with a strong electro-optic anisotropy allows this scenario; the interfering beams are polarized in a non-electro-optic direction and the probe is polarized along the crystalline c axis. In this arrangement, the interfering beams will propagate mostly linearly, while the signal beam will experience both a periodic potential and a significant (screening) nonlinearity. Our method of optical lattice induction allows for dynamic, reconfigurable arrays of almost any geometry. Typical experimental results are shown below.

Since this paper appeared (March 2003), it has been cited more than 110 times, being among the top 1% most cited in optics in the past 5 years. The ideas and methods presented in that paper are currently being followed by many groups world-wide. .





Experimental observation of the first 2D lattice soliton [figure taken from Fleischer et al, **Nature**, vol. 422, pp. 147, 2003]. The figure presents the propagation of a probe beam launched into a single waveguide at normal incidence with respect to the 2D photonic lattice.

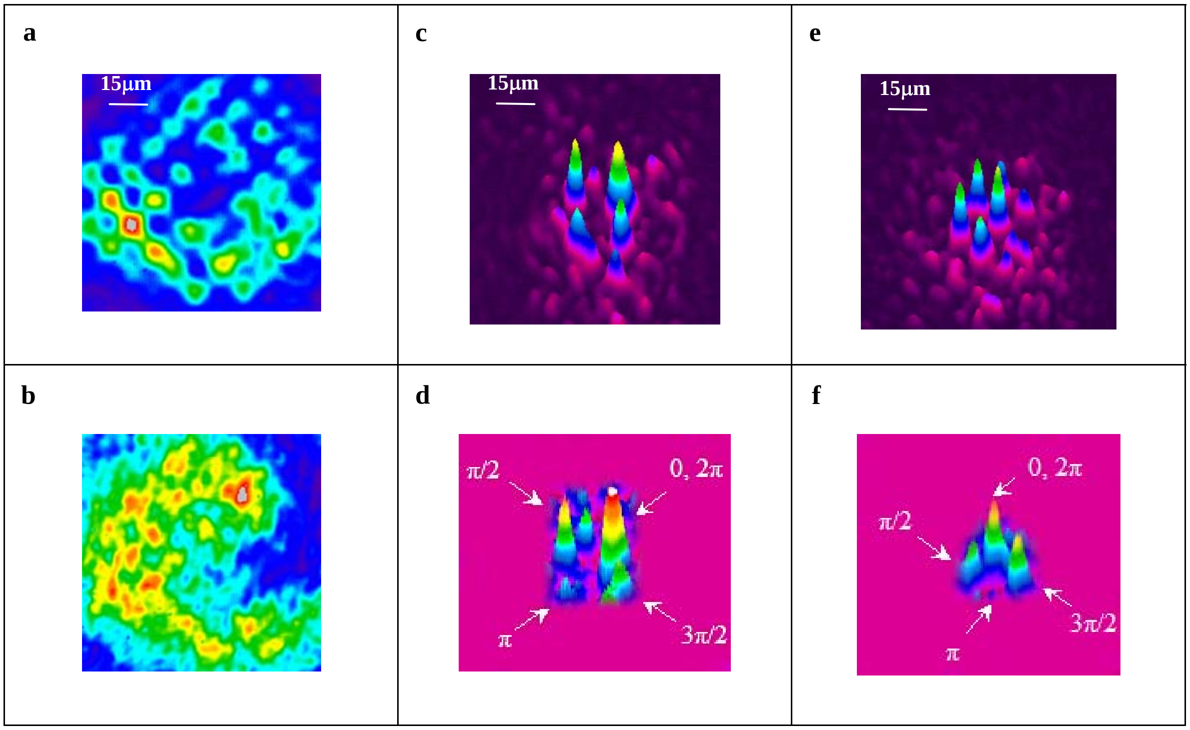
Upper left: Intensity structure of the probe beam at the lattice output, displaying diffraction-broadening at low nonlinearity (200V).
Upper right: Intensity structure of the probe beam at the lattice output, displaying an **on-axis lattice soliton** at high nonlinearity (800V).
Lower left: Reduction of probe intensity by x8, at the same voltage (800V), results in recovery of the diffraction-broadening pattern.
Lower right: Interferogram, showing constructive interference of peak and lobes between the soliton and a plane wave.

1.2 Spatial gap solitons and higher bands solitons

In the 3 years, our team has studied various manifestations of spatial gap solitons, which are the spatial analog of the temporal gap solitons forming when light interacts resonantly with a nonlinear periodic system. In 2003, we have made the first experimental observation of a bright spatial gap soliton [Fleischer et al**., Physical Review Letters**, vol. 90, pp. 23902, 2003]. It was done in a 1D configuration, in an optically-induced lattice similar to the 2D lattice described in Section 1.1, and two months later, we have reported the observation of the first 2D spatial gap solitons [Fleischer et al., **Nature**, vol. 422, pp. 147, 2003].

1.3 Vortex-ring “discrete” solitons in 2D photonic lattices

The observation of solitons in a two-dimensional nonlinear photonic lattice (described in the section above) has opened up many new fascinating possibilities. One of them is the observation of vortex solitons in photonic lattices. In a later study (Fleischer et al, **Physical Review Letters** vol. 92, pp. 123904, 2004), our team has presented the experimental observation of both on-site and off-site vortex-ring lattice solitons of unity topological charge in a square lattice. The experiments utilized the optical induction technique in a photorefractive crystal, for which the nonlinearity is inherently saturable. The experiments were accompanied by a theoretical study of such vortex-ring lattice solitons: we found the wavefunctions of on-site and off-site vortex lattice solitons, and demonstrated their stability. These vortex solitons are fundamental wave structures on 2D nonlinear lattices and can thus provide valuable insight into other systems in nature where similar dynamics can be potentially observed. For example, matter waves in optical traps and charge density waves in planes of conductive polymers can support solitons with topological charge. All-optical experiments also hold much potential for application, e.g. a 2D array of fiber lasers can excite a vortex mode whose output can drive a phase-sensitive object. Typical experimental results are shown below. **A picture from this work also featured on the cover of the relevant issue of Physical Review Letters [Volume 92, number 12, March, 2004].**

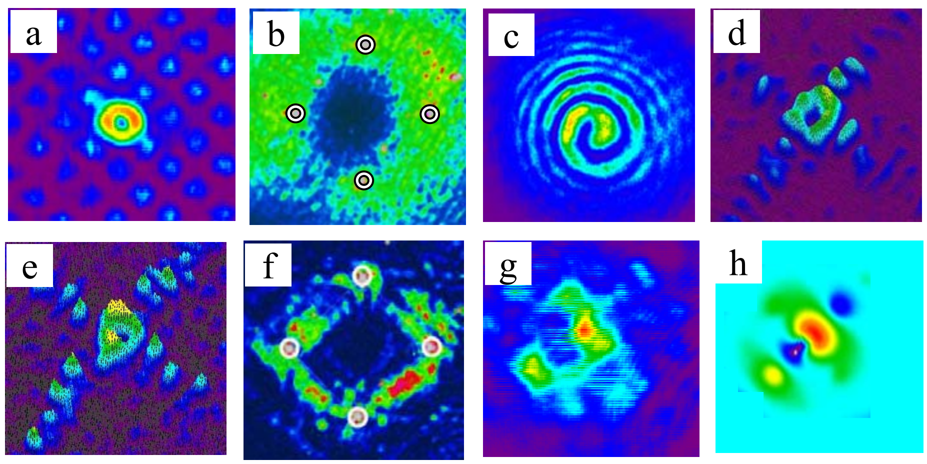


Experimental observation of vortex lattice solitons [figure taken from Fleischer et al, **Physical Review Letters** vol. 92, pp. 123904, 2004]. The photographs show results taken at the output of the photonic lattice.
(a,b) Linear diffraction results: (a) intensity and (b) phase information formed by interference of output with a plane wave.
(c) Typical **on-site lattice soliton** intensity and **(d)** soliton phase from an interferogram.
(e) Typical **off-site lattice soliton** intensity and (f) soliton phase from an interferogram

1.4 Second-band vortex-ring solitons in 2D photonic lattices

The observations of 2D lattice solitons (described in section 1.1) and of second-band lattice solitons (described in previous sections), have naturally raised the possibility of observing higher-band solitons in 2D photonic lattices. Indeed, our team has predicted [Manela et al., **Optics Letters,** vol. 29, pp. 2049, 2004], and later on experimentally observed [Bartal et al., **Physical Review Letters**, 2005] second-band solitons in 2D photonic lattices. These solitons arise from the X symmetry points of the 2nd band, and they reside in the gap between the 1st and the 2nd bands of a square lattice, i.e. they are **2D spatial gap solitons with vorticity**. These bright lattice solitons are characterized by a ring-shaped intensity profile, and a unique phase structure resembling a counter-rotating vortex array. Surprisingly, even though these solitons possess a complex structure (especially their vortex-array phase), they can be excited by launching a simple highly-localized vortex-ring beam.

Our simulations and experiments reveal that, under proper nonlinear conditions, a simple vortex ring excitation naturally evolves into the 2nd-band vortex-ring lattice soliton, acquiring its unique counter-rotating vortex-array phase structure during propagation. At low-intensities, such 2nd-band excitations display intriguing features of preferential linear diffraction along the lattice axes, which stand in sharp contrast to the diffractive behavior of 1st-band vortex excitations which takes on the (square) symmetry of the lattice. We demonstrated these 2nd-band vortex-ring lattice solitons, and studied their evolution dynamics experimentally and numerically. The figure below shows typical experimental results with such solitons. We anticipate that the dynamics observed here will appear in other nonlinear periodic systems, such as nonlinear fiber bundles, photonic crystal fibers, and Bose-Einstein condensates in the near future.

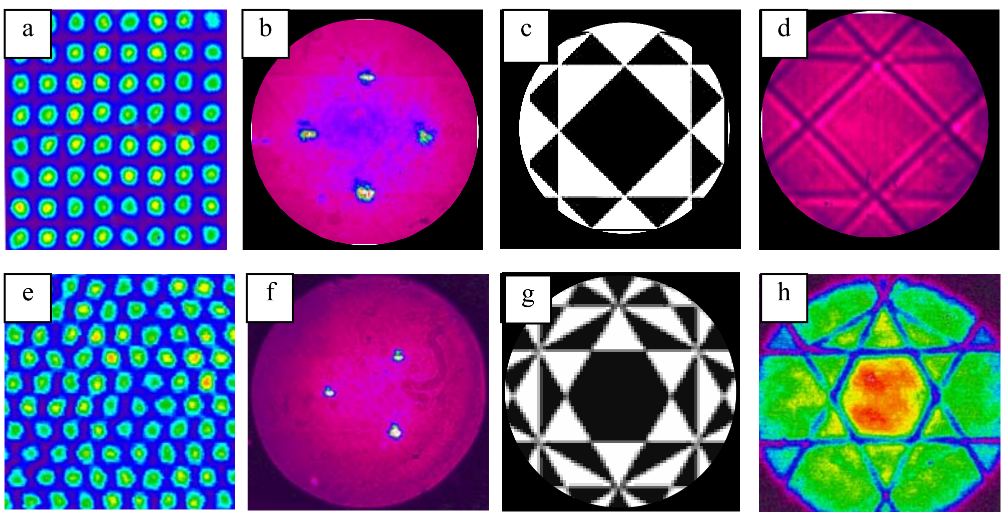


Experimental observation of second-band vortex lattice soliton. Intensity (a), power spectrum (b) and phase (c) of the excitation beam at the input plane of the lattice. (d) Linear diffraction of a low-intensity beam. (e) Intensity distribution of the second-band vortex soliton, along with (f) its Fourier power spectrum with respect to "corners" of the 1st Brillouin zone. (g) Phase information of the 2nd band vortex soliton, obtained by interference with plane waves. (h) Numerical validation of the phase information. This figure was taken from Bartal et al., accepted to **Physical Review Letters**, 2005.

1.5 Brillouin-zone spectroscopy of linear and nonlinear photonic lattices

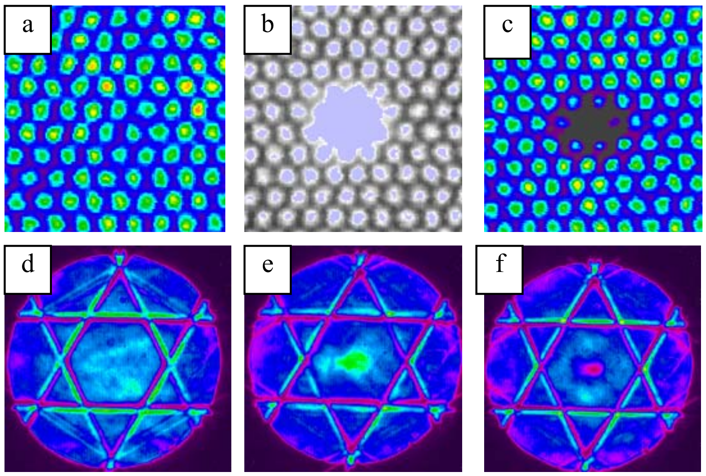
During the past year, our team has developed a novel, real-time, experimental technique for linear and nonlinear Brillouin zone spectroscopy of photonic lattices [see Bartal et al., **Physical Review Letters**, vol. 94, pp. 163902, 2005]. The method relies on excitation with random-phase (partially-incoherent) waves and far-field visualization of the spatial spectrum of the light exiting the lattice. This method allows the characterization of the underlying lattice structure, while mapping out the borders of the extended Brillouin zones and marking the areas of normal and anomalous dispersion within them. Specifically for photonic lattices with defects (e.g., photonic crystal fibers), the technique enables far-field visualization of the defect mode (guided mode) overlay on the extended Brillouin zones structure of the lattice. The technique is general and can be used for photonic crystal fibers as well as for periodic structures in areas beyond optics.

The ideas facilitating this spectroscopy method rely on linear and nonlinear propagation of random-phase waves in a photonic lattice. To map out the momentum space of a lattice, the lattice should be probed by a broad spectrum of its eigen-modes in the mapped region of k-space. Preferably, one would like to excite the lattice with a broad and uniform spectrum of Bloch modes, residing in several different bands. At the same time, the probe beam must also be broad enough in real space, sampling a large enough number of unit cells so that the lattice is well defined. It is therefore desirable to probe the lattice with a beam that is broad both in real space and in k-space simultaneously. These requirements are reconciled simultaneously by a random-phase probe beam, which facilitates homogeneous excitation of several Brillouin zones with a beam that occupies numerous lattice sites. Moreover, the time-averaged intensity of such an incoherent probe beam, which excites many Bloch modes, has no speckles, because all interference effects (among Bloch modes) are washed out by the stochastic fluctuations upon the incoherent beam. Thus, one can probe the photonic lattices with a partially-spatially-incoherent (random-phase) beam, which has a uniform spatial power spectrum extending over several Brillouin zones, and is broad enough to cover numerous lattice sites. Typical results depicting the extended Brillouin zone map of two photonic lattices (a square lattice and an hexagonal lattice) are shown below.



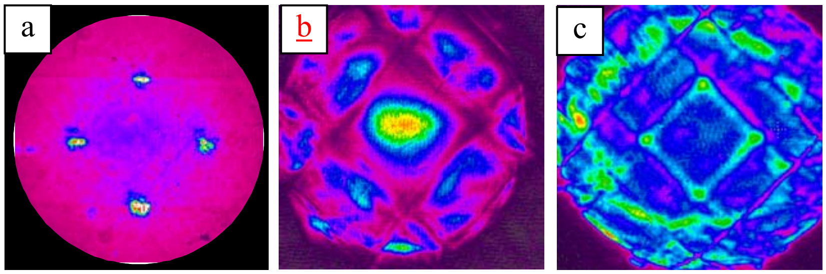
Linear mapping of the edges of Brillouin zones of square and hexagonal lattices [figure taken from Bartal et al., **Physical Review Letters**, vol. 94, pp. 163902, 2005]. (a) Interference pattern of the array waves inducing the photonic lattice with the square symmetry. (b) Fourier spectrum of the incoherent probe beam (broad circle) and lattice forming beams (four sharp peaks) at the input to the lattice. (c) Calculated extended Brillouin zone map of a square lattice. (d) Experimental Fourier spectrum of the probe beam at the lattice output. (e)-(h) Same as (a-d) with a hexagonal lattice.

The Brillouin zone spectroscopy method also allows direct visualization of power spectrum of waves propagating in lattices with defects. The figure below shows an example with a hexagonal lattice with positive and negative defects. The upper row depicts the near-field photograph of the lattice without a defect (a), and with a positive (b) and a negative (c) defect. The lower row (d-f) shows the corresponding (far-field) power spectrum of the probe beam in each case. For the positive defect, the guided modes (bound states) arise from total-internal-reflection of states occupying the central region of the first Brilluoin zone. Consequently, the far-field of these guided modes is clearly apparent as a wide spot in the center of the first Brilluoin zone of (e). On the other hand, for a negative defect (for which the average refractive index is lower in the guiding region), waveguiding arises solely from Bragg reflections, and not from total-internal-reflections. Consequently, the central region of the Brilluoin-zone picture is empty [not populated; the central "hole" in (f)], and the guided modes are the states whose momentum arises from the edge of the first Brillouin zone [bright concentric ring in (f))].



Defect modes in a hexagonal lattice [figure taken from Bartal et al., **Physical Review Letters**, vol. 94, pp. 163902, 2005]. Near field of the hexagonal lattice (a) with no defect, (b) with a positive defect, and (c) with a negative defect. Power spectrum of the incoherent probe beam exiting the hexagonal lattice (d) with no defect, (e) with a positive defect, and (f) with a negative defect.

Finally, when the photonic lattice is nonlinear, the underlying self-focusing (or self-defocusing) interaction among the Bloch modes results in energy exchange between these lattice eigen-modes. This interaction facilitates a method for distinguishing between the regions of normal and anomalous diffraction (dispersion) of the underlying lattice, and mapping out the boundaries between dispersion of opposite signs. In these experiments, the probe beam is propagating ***nonlinearly*** in the photonic lattice, and it drives the nonlinear interaction by inducing a broad defect in the lattice structure, which in turn causes energy exchanges between Bloch modes. Typical experimental results are shown in the figure below. The excitation (far-field) power spectrum of the incoherent probe-beam is shown in (a). When the lattice exhibits a nonlinearity of a self-focusing type, the wide probe beam induces a wide (and shallow) positive defect in the lattice (deeper potential / increased refractive index). The presence of such a defect causes Bloch modes with anomalous diffraction to transfer power to Bloch modes experiencing normal diffraction. This is depicted in (b) where the waves residing at the regions of normal diffraction have a considerably higher intensity than the low-intensity regions of anomalous diffraction. In a similar fashion, when the lattice exhibits a nonlinearity of the self-defocusing type, energy transfers from normal-diffraction Bloch modes to anomalous-diffraction states, highlighting the higher intensity (anomalous diffraction) regions in (c), adjacent to the lower intensity (normal diffraction) regions in the same far-field power spectrum.



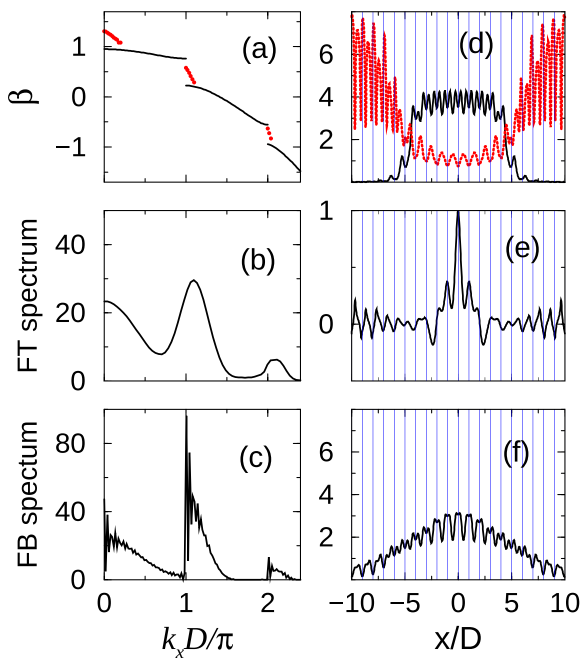
Dispersion mapping of a square lat1tice [figure taken from Bartal et al., **Physical Review Letters**, vol. 94, pp. 163902, 2005]. (a) Fourier spectrum of the probe beam (circle) and of the lattice-forming beams (four dots) at the input. Experimental Fourier spectrum of the probe beam at the output face of the square lattice under (b) self-focusing nonlinearity and (c) self-defocusing nonlinearity

To conclude this section, the technique for linear and nonlinear Brillouin zone spectroscopy of photonic lattices, albeit being published last month, has already generated much interest. The method is general and can be used for any periodic optical structure, including photonic crystals and photonic crystal fibers. The magazine **Physics Today** has published a commentary about this work in the May 2005 issue, in the Physics Update section.

1.6 Random-phase lattice solitons

Nonlinear systems with inherent periodicity are abundant in nature Examples may be found in biology, chemical physics, nonlinear optics, Josephson-junction ladders, Bose-Einstein condensates (BEC), etc. Optics especially has provided important advances and holds great promise for applications (e.g. nonlinear photonic crystals). The main feature of wave propagation in periodic systems is the interference of waves reflected from the lattice, which drives the propagation dynamics. These interference effects depend crucially on the coherence of the waves. However, in nonlinear periodic lattices, only coherent waves have been considered thus far. Since most waves encountered in nature are only partially coherent, theories assuming perfectly coherent waves are idealizations, which are nevertheless accurate when the characteristic length describing the coherence of waves exceeds by far the characteristic dimension of the system (e.g., the lattice spacing). However, when the two length-scales are comparable, the interference effects, and consequently the dynamics, will depend on the interplay between the statistical (coherence) properties of the waves and the lattice periodicity.

In paper published in 2004 [Buljan et al., **Physical Review Letters,** vol. 92, pp. 223901, 2004]. our team has present the first theoretical study on the propagation of partially coherent waves in nonlinear periodic lattices, and predicted the existence of random-phase solitons in nonlinear periodic lattices. These solitons are found in media where the nonlinear response time is much longer than the characteristic time of random phase fluctuations. A random-phase lattice soliton forms when the time-averaged intensity of an incoherent wavepacket induces a defect in the periodic potential which has multiple bound states; the wavepacket "binds" itself to that defect by randomly populating these states in a self-consistent fashion (on the time-average). For random-phase lattice solitons to exist, their intensity profiles, power spectra, as well as their statistical (coherence) properties must conform to the lattice periodicity. **The main theoretical findings are summarized in the theory figure below.**

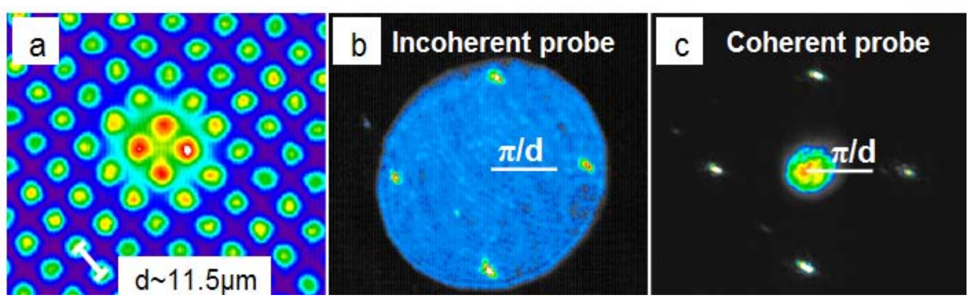


Theory: properties of random-phase lattice solitons – RPLS

(figure taken from Buljan et al., **Physical Review Letters,** vol. 92, pp. 223901, 2004)

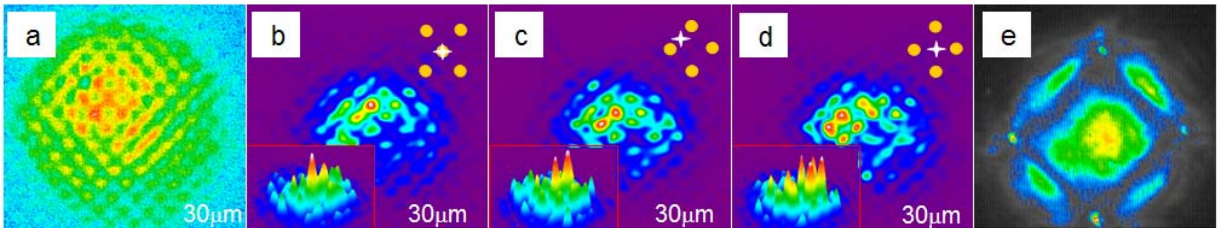
(a) Propagation constants of the modal constituents of RPLS. (b,c) The power spectrum on an RPLS in the Fourier and in the Floquet-Bloch bases, respectively. (d) Intensity profile of an RPLS (black) and the corresponding correlation distance across it. (e) the mutual correlation function of the RPLS example. (f) Characteristic diffraction-broadening when (d) in the absence of nonlinearity.

The experiments followed soon thereafter, and earlier this year our team has published the first observation of random-phase solitons in photonic lattices [Cohen et al., **Nature**, vol. 433, pp. 500, 2005]. A typical observation of a random-phase lattice soliton (RPLS) is depicted in the figures below.



Experimental images at the input of the 2D photonic lattice [figure taken from Cohen et al., **Nature**, vol. 433, pp. 500, 2005].

(a) Real-space picture of induced square lattice and the random-phase probe beam. (b) Power spectrum of the incoherent probe beam (wide circle) and lattice beams (four dots), which define the corners of the first Brillouin zone. (c) Same as (b) but with coherent probe beam that has the same size in real space (as in (a)).



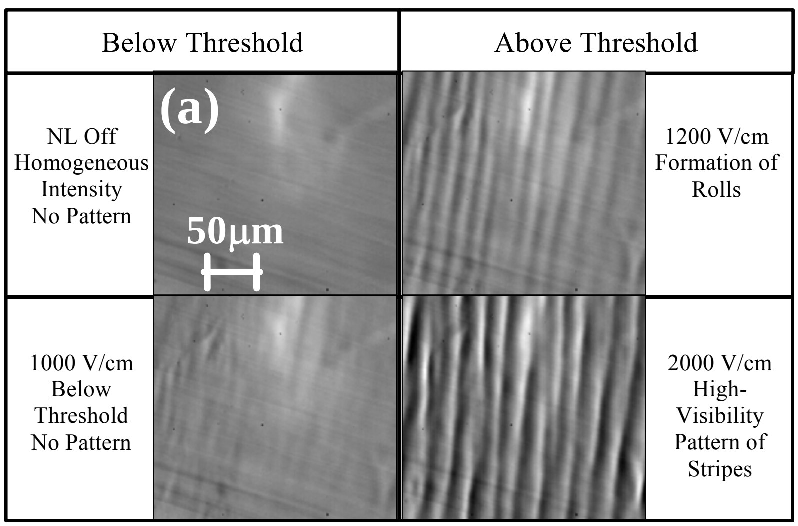
Experimental observation of random-phase lattice solitons [figure taken from Cohen et al., **Nature**, vol. 433, pp. 500, 2005].
Shown are images at the output of the 2D photonic lattice. (a) Linear lattice diffraction of the incoherent beam at low intensity. (b-d) Real space pictures of random-phase lattice solitons centered (b) on a site, (c) between two sites, and (d) between four sites. The insets show 3D perspectives of the solitons. Note that (a)-(d) have the same scale. (e) Power spectrum of random-phase lattice solitons displaying its square symmetry and multi-humped structure with the peaks located in the normal diffraction regions of the first two bands. The four dots correspond to the power spectrum of the array beams.

1.7 Modulation instability and spontaneous formation of solitonic patterns with incoherent "white" light

One of the most fundamental phenomena in nonlinear dynamics is the spontaneous formation of ordered structures, known as pattern formation or modulational instability (MI) and it has been observed and studied throughout all fields of science such as fluids dynamics and plasmas, biological and chemically reacting systems, optics and many others. Essentially MI is a process in which a nonlinear system in a spatially homogeneous state is becoming unstable to small fluctuations and perturbations with a specific periodicity. The perturbations are enhanced through the nonlinearity, until diffraction or dispersion counterbalances the effect and a regular pattern (typically stripes, rectangles or hexagons) is formed. In optics, MI has been reported in many materials with diverse nonlinearities, and although the mechanisms driving MI are different, the MI process itself possesses similar properties and behavior. Until recently, pattern formation in nonlinear optical systems was studied with fully coherent light, relying on the intuition that spatial correlations are necessary for wave amplification. However, 5 years ago, we have shown theoretically and experimentally [Kip et al., **Science,** vol. 290, pp. 495, 2000] that a partially-coherent, yet quasi-monochromatic, light beam can also undergo MI breakup resulting in a periodic array of spatially incoherent 1D or 2D soliton-like filaments. This incoherent MI is distinguished from coherent MI by the presence of a distinct threshold for the instability to occur. That is, MI occurs only when the nonlinear self-focusing is strong enough to compensate for the diffraction of light, determined by the spatial correlation function. Another mandatory condition for incoherent MI and pattern formation to occur is a non-instantaneous response of the nonlinear material, so that the nonlinear change of the refractive index is a function of the time-averaged intensity (and not of the instantaneous intensity).

Motivated by the observation of optical spatial solitons made of incoherent white light emitted from a bulb [Mitchell and Segev, **Nature**, vol. 387, pp. 880, 1997], our team has started to investigate MI of white light (that is, light which is both spatially and temporally incoherent). First, a new general theory was developed, being able to handle the propagation of incoherent "white light" in non-instantaneous nonlinear systems [see Buljan et al., **PRE**, vol. 66, pp. 35601, 2002]. The theory predicted that MI should occur with white light, in spite of the temporal and spatial incoherence. Similar to the spatially-incoherent yet quasi-monochromatic case, the instability occurs only when the nonlinearity exceeds a threshold value. However, with white light (wide temporal spectrum) the theory has indicated that the MI process possesses some new features: the system becomes unstable for all wavelengths together, at the same nonlinearity value, and all the temporally frequencies that make up the temporal spectrum of the white light **collectively** participate in the formation of the pattern. Therefore the temporal spectrum of the evolving perturbation self-adjusts as the beam propagates to match the collective MI phenomenon

With this theoretical backing in hand, our team has made the first experimental observation of modulation instability and spontaneous pattern formation with incoherent "white" light emitted by an incandescent light bulb [see Schwartz et al., **Physical Review Letters**, vol. 93, pp. 223901, 2004]. . We have shown that, above the MI threshold, a pattern consisting of white light stripes forms, and that this pattern exhibits unique dependence on wavelength. We have shown experimentally that the MI threshold value is **the same** for all temporal frequencies, indicating that the process is indeed collective. Increasing the nonlinearity beyond the threshold results in the enhancement of the modulation depth of the periodic pattern until it saturates. The figure below shows typical experimental results. This work has also featured in the December 2004 issue of **Physics Today** in the Physics Update section.



Intensity distribution at the exit face of the nonlinear crystal for different strengths of nonlinearity, showing the well defined threshold for white-light MI. [Figure taken from Schwartz et al., **Physical Review Letters**, vol. 93, pp. 223901, 2004).

1.8 Theory of incoherent white light solitons

Our team has theoretically investigated the properties of solitons made of temporally and spatially incoherent light, that is, white light solitons. Their evolution dynamics revealed that the spatio-temporal coherence properties of the input light beam change in a characteristic fashion, and self-adjust to form a soliton. We identified the characteristic features of the temporal power spectrum and spatio-temporal coherence properties of white light solitons. More specifically, the spatial intensity profile of light within their bandwidth is wider (less localized) at lower frequencies, and narrower at higher frequencies. Furthermore, the spatial correlation distance (across the soliton) is always larger for lower frequencies, and shorter for higher frequencies. We have studied white light solitons with two generic types of nonlinearities: the saturable nonlinearity and the Kerr nonlinearity when both have a non-instantaneous response (see Buljan et al., **Optics letters**, vol. 28, pp. 1239, (2003)]. In a follow up study we have investigated the properties of white light incoherent solitons, analytically, in a logarithmically-saturable nonlinear media (Buljan et al., **PRE**, vol 68, pp. 036607, 2003). We found closed-form solution representing temporally and spatially incoherent solitons. These incoherent solitons were found to have an elliptic Gaussian intensity profile, and elliptic Gaussian spatial correlation statistics. The existence curve of such a soliton connects the strength of the self-focusing, the spatial correlation distance at a particular frequency, and the characteristic width of the soliton. From the existence curve it follows that these solitons exist only when the spatial correlation distance is smaller for higher frequency constituents of the light.

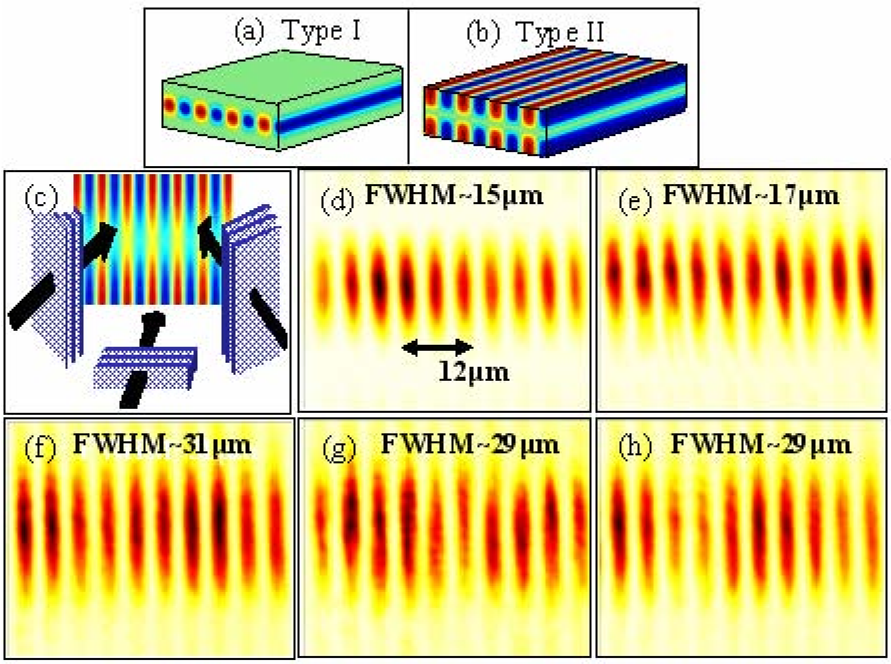
1.9 Grating-mediated-waveguides

Optical waveguides are widely used in modern optoelectronic systems. Optical fibers serve as the backbone of today's high-bandwidth telecommunication networks while many system components utilize the properties of waveguide structures. Thus far, three physical mechanisms for optical waveguiding are known: Total internal reflection (TIR), "photonic band gap" (PBG) waveguiding, and the CROW (Coupled Resonator Optical Waveguide) systems.

Recently, our team has proposed and experimentally demonstrated a new method for optical waveguiding: **Grating-Mediated Waveguiding (GMW)** [Cohen et al., **Physical Review Letters**, vol. 93, pp. 103902, 2004]. A GMW consists of a structure uniform in the z-direction (propagation direction) in which waveguiding is driven by a shallow 1D grating in x, which is perpendicular to both the propagation direction z, and to the confinement direction y. This grating has a bell-shaped or a trough-shaped amplitude in y, that is, in the direction normal to the grating wave-vector (see panels a and b in the figure below). Waveguiding in this system occurs when two angularly symmetric Bragg-matched beams are incident upon the grating, with an appropriate relative phase. These beams are simultaneously Bragg-reflected from the grating, and are *jointly guided in the direction normal to the grating wave- vector*. In the case where the probe beams are not Bragg-matched, or if their relative phase is improper, no waveguiding occurs and the beams diffract.

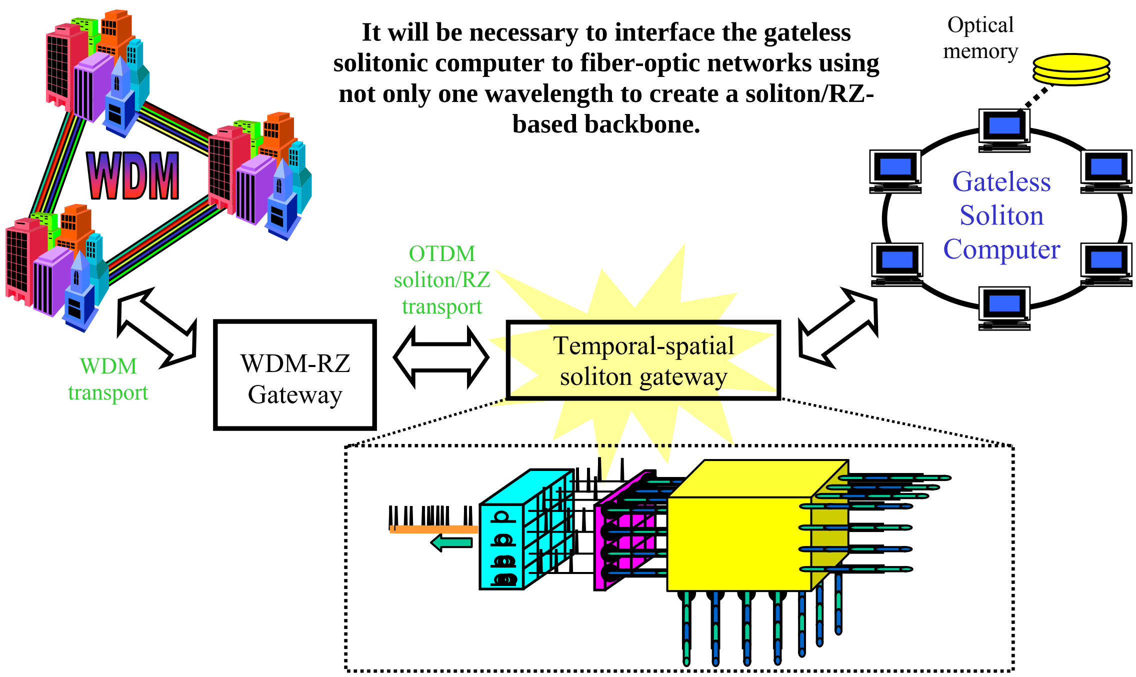
We proved the GMW idea theoretically, and demonstrated its concept experimentally in a grating-mediated-waveguide induced in a photorefractive SBN crystal. We induce a trough-shape GMW structure by interfering two ordinarily-polarized plane waves (inducing an index grating), and illuminating the central interference region with another ordinarily-polarized beam, which is very narrow in y and is made incoherent with the interfering waves [panel c in the figure below]. To test waveguiding, we launch the probe beams into the structure and observe their propagation. The probe beams are extraordinarily-polarized, hence they "feel" the waveguide structure, yet they are made sufficiently weak so that do not affect the induced index structure. Typical experimental results are shown in the figure below.

It is important to emphasize the **difference** between GMW and PBG or TIR waveguides. In PBG waveguides, the reflections are in the plane defined by the propagation and confinement directions, while for GMW, the grating is perpendicular to the direction of confinement. Likewise, in TIR structures, the light is confined in regions of higher refractive index with no Bragg reflections, whereas for GMW, the waveguiding is based on Bragg reflections and all the waveguide “layers” have the same average refractive index. This last argument is readily apparent in "trough" GMW, where waveguiding is achieved even though light is not concentrated in the regions of the peaks of the refractive index. To summarize, we have proposed and demonstrated grating-mediated-waveguiding, in which confinement is perpendicular to the grating wavevector. As with all other waveguiding mechanisms, GMW will undoubtedly find use in a variety of photonic applications. Moreover, the GMW structures described here will work in other wave systems as well, such as acoustic systems and condensate matter waves in periodic potentials.



Grating-mediated waveguiding. (a,b) Schematic drawings of GMW with a bell (a) and a trough (b) transverse amplitude. (c) Experimental scheme for inducing a trough-shape GMW in photorefractives. (d-h) Experimental photographs of a probe beam at the input (d) and output (e) of the waveguide providing an experimental proof of concept for GMW. (f-h) Diffraction in unguided conditions: a homogeneous medium (f), when the beams are not Bragg-matched with the index grating (g), when the beams are Bragg-matched with the grating but have the "wrong" phase relative to the grating (h). The intensity in each panel is normalized to the peak intensity. This figure was taken from Cohen et al., **Physical Review Letters**, vol. 93, pp. 103902, 2004.

All-optical Temporal-Spatial Soliton Gateway



Scientific Progress and Accomplishments

This report covers our activities and lists the most significant accomplishments for the covered period 2000-2005. Our activities were focused on developing enabling technologies to create important building blocks for an all-optical temporal-spatial soliton gateway and its peripherals. Here we report the following highlights:

1) All-optical wavelength conversion
2) Investigating optical spectral bistability for all-optical switching and optical memory applications
3) Quantum theory of Manakov solitons
4) Multicomponent gap solitons in superposed gratings
5) Quantum phase noise reduction in soliton collisions

1) All-optical wavelength conversion

Solitonic signal processing uses the fundamental characteristics of optical solitons to achieve multiple functionalities. We made a significant breakthrough, both theoretically and experimentally, in building a gateway with all-optical wavelength conversion capabilities using a Sagnac interferometric loop with an SOA at asymmetric position . <u>We filed a patent disclosure for this invention.</u>

All-optical wavelength conversion is one of the most important functionalities for optical signal processing, which has found wide applications for ultra short optical pulses / temporal solitons. We showed that the structure could be used for non-return-to-zero signals as well.

2) All optical bistability with application for all-optical memory

In November 2002, during the review process we had a live demonstration of optical spectral bistability in a semiconductor ring laser, in which hysteresis of the laser spectrum was observed in response to an optical control signal. The lack of a viable technology for bit level random access optical memory is a limiting factor towards the development of truly intelligent optical networks. Optical bistability in lasers with semiconductor gain media is a promising approach toward developing bit level optical memories. First we demonstrated a Bistable Semiconductor Fiber Ring Laser (BSFRL) that exhibits tunable bistable wavelength operation near the 1.55µm region. The corresponding hysteresis curves are shown in the figure below.

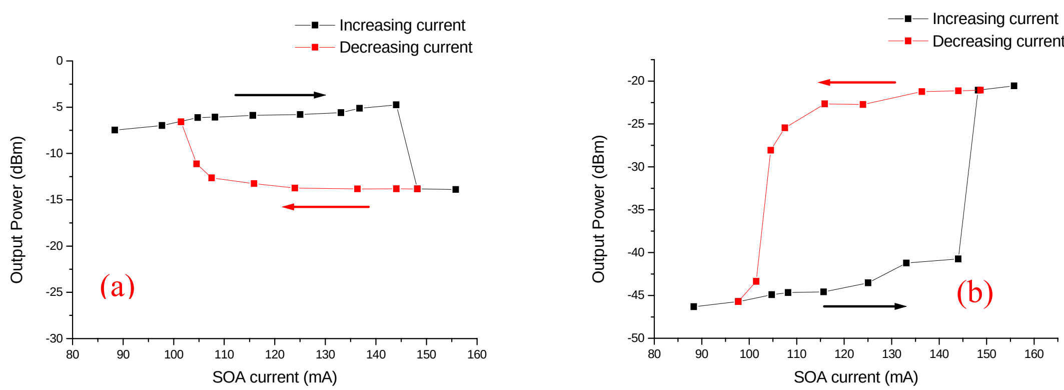


Fig. The two bistable states of the BSFRL. (a) State 1 shows a narrow spectral peak at 1570.6 nm; (b) State 2 has two broad peaks at 1570.6 nm and 1579.0 nm.

3) Quantum theory of Manakov solitons

In an effort to determine the potential of communications and computation systems using Manakov solitons, the Princeton team has developed a quantum theory of Manakov solitons. The theory is used to illustrate the vacuum-induced fluctuations on Manakov soliton propagation and collision. This approach is used to evaluate the performance of systems using Manakov solitons.

4) Multicomponent gap solitons in superposed gratings

We investigated the stable propagation of multicomponent gap solitons (strictly speaking, solitary waves) in superposed gratings, non-uniform structures consisting of overlapped gratings. Multicomponent gap solitons are comprised of multiple pulses, with different carrier frequencies, corresponding to the multiple gaps in a superposed grating. We analyzed the existence and stability of such localized waves through direct numerical simulation of the nonlinear coupled-mode equations which describe this physical system.

Parts (a-c) of the figure show a stationary gap soliton, and parts (d-f) demonstrate a moving gap soliton. Parts (a,d) are for one component, (b,e) for two components, and (c,f) for three components. For the two and three component solitons, we see stable propagation along with emission of dispersive radiation. Due to the periodic boundary conditions used, the radiation wraps around and, in the case of parts (b) and (c), collides with the soliton. This perturbation does not effect the propagation, further supporting the stability of these localized waves.

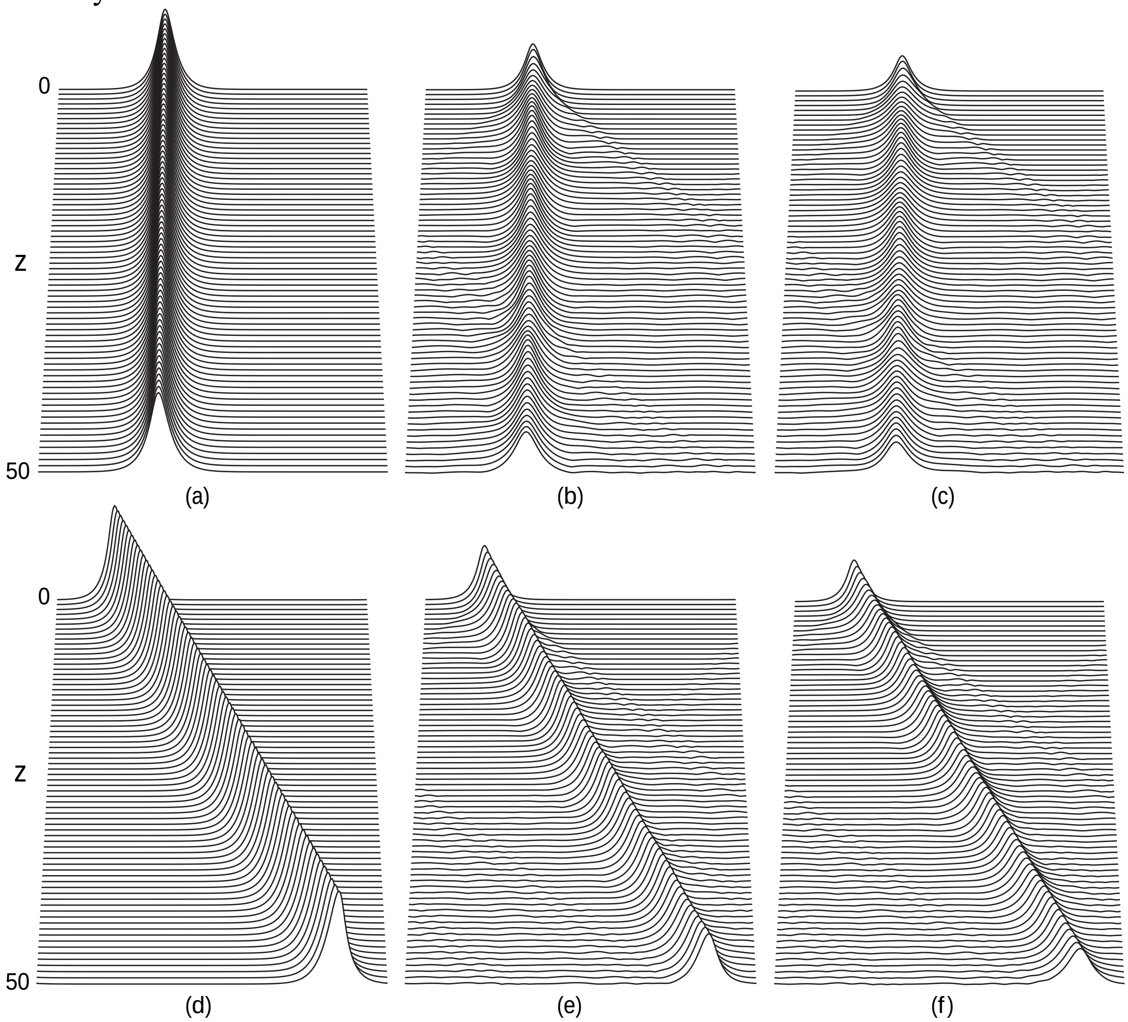
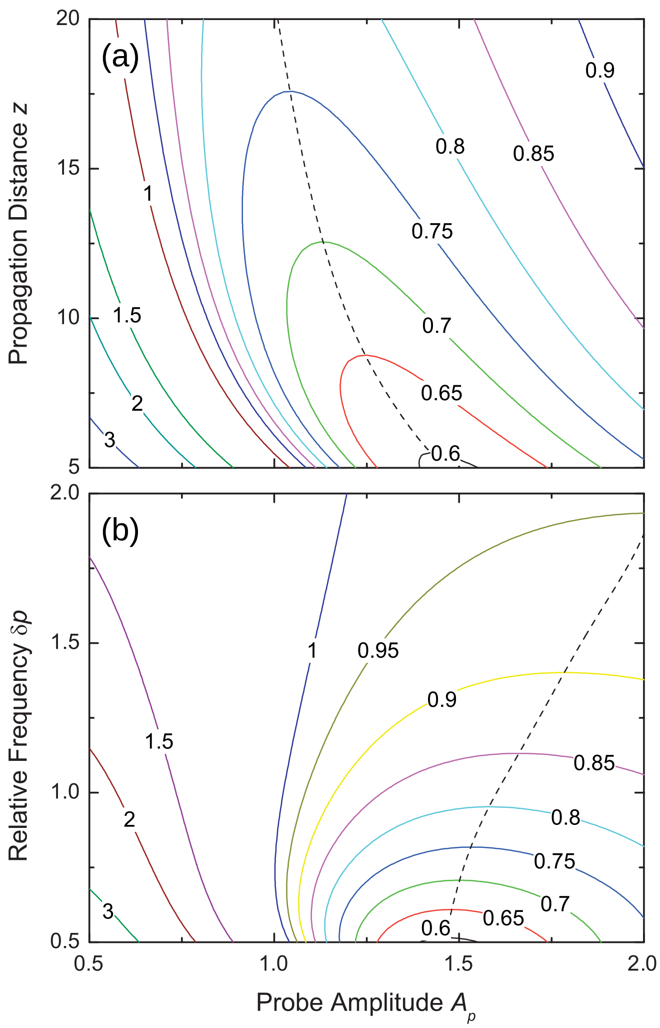


Fig. Multicomponent gap soliton. See text for details.

5) Quantum phase noise reduction in soliton collisions

We discovered a new physical effect—that phase noise is reduced by a soliton collision, because of a negative correlation between phase fluctuations induced by self-phase modulation (SPM) and cross-phase modulation (XPM). We then showed how this effect can be exploited to improve quantum nondemolition (QND) measurements. The effect itself is straightforward to implement since it only requires operating in a new parameter regime, and hence does not require any new materials or detection techniques. We show that both the optimization of phase noise reduction and accurate QND measurements favor short propagation distances, small wavelength separation between solitons, and, in general, a larger probe amplitude with respect to the signal. This last property is particularly surprising, given the direct correspondence between amplitude and SPM-induced phase noise, a characteristic which has motivated the choice of smaller probe than signal solitons in experiments. Higher fidelity QND measurements may lead to new applications in quantum information with continuous variables, as well as improve QND-based entanglement and various applications, including entanglement purification and teleportation.

The overall phase fluctuations are measured through a ratio between the collision-induced phase noise variance with respect to the variance in the absence of collision. This ratio is plotted in the figure as a function of probe amplitude, where the signal amplitude is kept fixed at 1. The increase in the variance ratio with increasing propagation distance, shown in part (a) of the figure, arises due to SPM-induced phase noise, which tends to drown out the phase reduction at long propagation distances. In addition, the variance reduction favors a larger probe. The ratio can also be minimized for small wavelength separation between probe and signal. This trend is shown in part (b) of the figure, in which $z=5$, and also demonstrates decreased fluctuations of a larger probe amplitude with respect to the signal.



We predict a twofold improvement in the error variance of a QND measurement using this effect.

6) List of Manuscripts

6a Papers 233 published relevant to MURI activities in all years

1. P. Dumais, A. Villeneuve, A. Saher-Helmy, J. S. Aitchison, L. Friedrich, R. A. Fuerst and G. I. Stegeman, “Towards soliton emission in asymmetric GaAs/AlGaAs multiple-quantum-well waveguide structures below the half bandgap”, Opt. Lett., **25**, 1282-4 (2000)

2. H. Fang, R. Malendevich, R. Schiek and G. I. Stegeman, “Spatial Modulational Instability in One-Dimensional $LiNbO_3$ Slab Waveguides”, Opt. Lett., **25**, 1786-8 (2000)

3. L. Friedrich, R. Malendevich, G. I. Stegeman, J. M. Soto-Crespo, N. N. Akhmediev and J. Stewart Aitchison, ″Radiation Related Polarization Instability of Fast Kerr Spatial Solitons in Slab Waveguides″, Opt. Comm., **186**, 335-41 (2000)

4. G. I. Stegeman, D. N. Christodoulides, and M. Segev, “Optical Spatial Solitons: Historical Perspectives”, (invited paper, Millenium Issue), IEEE J. Selected Topics in Quant. Electron., Millenium Issue, **6**, 1419-27 (2000)

5. T. H. Coskun, A. G. Grandpierre, D. N. Christodoulides, and M. Segev, “Coherence enhancement of spatially incoherent light beams using interactions with incoherent and coherent dark solitons”, Opt. Lett., **25**, 826-8 (2000).

6. E. D. Eugenieva, D. N. Christodoulides, and M. Segev, “Elliptic incoherent solitons in saturable nonlinear media”, Opt. Lett., **25**, 972-4 (2000).

7. T. Carmon, C. Anastassiou, S. Lan, D. Kip, Z. H. Musslimani, M. Segev, and D. N. Christodoulides, “Observation of two-dimensional multimode solitons”, Opt. Lett., **25**, 1113-5, (2000).

8. D. Kip, M. Soljacic, M. Segev, E. Eugenieva, and D. N. Christodoulides, “Modulation instability and pattern formation in spatially incoherent light beams”, Science, **290**, 495, (2000).

9. A. G. Grandpierre, T. H. Coskun, D. N. Christodoulides, M. Segev, and Y. S. Kivshar, “Gray spatial solitons in biased photorefractive media”, J. Opt. Soc. Am. B, **18**, 55-63, (2000).

10. M. I. Carvalho, A. G. Grandpierre, D. N. Christodoulides, and M. Segev, “Optical spatial shock-waves in photorefractive media”, Phys. Rev. E, **62**, 8657, (2000).

11. D. Kip, M. Soljacic, M. Segev, E. Eugenieva, and D. N. Christodoulides, “Modulation instability of spatially-incoherent light beams and pattern formation in incoherent wave systems”, Opt. Phot. News, **11**, 34-5, (2000).

12. C. Anastassiou, M. Soljacic, M. Segev, E. D. Eugenieva, D. N. Christodoulides, D. Kip, Z. H. Musslimani, and J. P. Torres, “Eliminating the transverse instabilities of Kerr solitons”, Phys. Rev. Lett., **85**, 4888-91, (2000).

13. Z. H. Musslimani, M. Soljacic, M. Segev, and D. N. Christodoulides, “Delayed-action interaction and spin-orbit coupling between solitons”, Phys. Rev. Lett., **86**, 799-82, (2001).

14. M. Soljacic and M. Segev, "Integer and fractional angular momentum borne on self-trapped necklace-ring beams", Phys. Rev. Lett. **86**, 420 (2001).

15. V. V. Steblina, A. Buryak, R. A. Sammut, D. Zhou, M. Segev and P. R. Prucnal, "Stable self-guided propagation of two optical harmonics coupled by a microwave or a THz wave", J. Opt. Soc. Am. B **17**, 2026 (2000).

16. S. Lan, C. Anastassiou, M. Segev, M. Shih, J. A. Giordmaine, and G. Mizell, "Tuning of second harmonic generation in waveguides induced by photorefractive spatial solitons", Appl. Phys. Lett. **77**, 2101 (2000).

17. M. Soljacic and M. Segev, "Self-trapping of electromagnetic beams in vacuum supported by QED nonlinear effects", Phys. Rev. A **62**, 43817 (2000).

18. M. Soljacic and M. Segev, "Self-trapping of necklace-ring beams in self-focusing Kerr media", Phys. Rev. E **62**, 2810 (2000).

19. S. Sears, M. Soljacic, M. Segev, D. Krylov and K. Bergman, "Cantor set fractals from solitons", Phys. Rev. Lett. **84**, 1902 (2000).

20. M. Soljacic, M. Segev and C. R. Menyuk, "Self-similarity and fractals in soliton-supporting systems", Phys. Rev. E **61**, R1048 (2000).

21. Z. H. Musslimani, M. Segev, D. N. Christodoulides, and Marin Soljacic, "Composite multi-hump vector solitons carrying topological charge", Phys. Rev. Lett. **84**, 1164 (2000).

22. M. Soljacic, M. Segev, T. Coskun, D. N. Christodoulides, and A. Vishwanath, "Modulation instability of incoherent beams in non-instantaneous nonlinear media", Phys. Rev. Lett. **84**, 467 (2000).

23. Z. H. Musslimani, M. Segev, and D. N. Christodoulides, "Multi-component two-dimensional solitons carrying topological charge", Opt. Lett. **25**, 61 (2000).

24. P. Ballet, J.B. Smathers, H. Yang, C.L. Workman and G.J. Salamo, “Scanning tunneling microscopy investigation of truncated InP/$GaInP_2$ self-assembled islands”, Appl. Phys. Lett**., 77,** 3406-8, (2000).

25. F. Hegeler, M. O. Manasreh, C. Morath, P. Ballet H. Yang, G. J. Salamo, H. H. Tan, C. Jagadish, “Thermal Annealing Recovery of Intersubband Transitions in Proton Irradiated GaAs/AlGaAs Multiple Quantum Wells”, Appl. Phys. Lett.**,77,** 2867-9, (2000)**.**

26. Y. Lu, M. Xiao and G. J. Salamo, “Wide-bandwidth high-frequency electro-optic modulator based on periodically poled $LiNbO_3$”, Appl. Phys. Lett., **78,** 1035-7, (2001)

27. D. N. Christodoulides, E. D. Eugenieva, T. H. Coskun, M. Segev, and M. Mitchell, “On the equivalence of three approaches describing partially incoherent wave propagation in inertial nonlinear media”, Phys. Rev. E, **63**, 35601, (2001).

28. P. Toliver, I. Glesk, and P. R. Prucnal, "All-optical clock and data separation technique for asynchronous packet-switched OTDM networks", Opt. Comm. **173,** 101-106 (2000)

29. I. Glesk, J. Runser, Kung-Li Deng and P. R. Prucnal, "100 Gbit/s Computer Optical Interconnect", Acta Physica Slovaca **50**, 229-234 (2000)

30. K.L. Deng, R. J. Runser, I. Glesk, and P. R. Prucnal, "Demonstration of Multicasting in a 100-Gb/s OTDM Switched Interconnect", IEEE Phot. Techn. Lett. **12**, 558-560 (2000).

31. P. Toliver, R. J. Runser, I. Glesk, and P. R. Prucnal, "Comparison of three nonlinear interferometric optical switch geometries", Opt. Comm. **175,** 365-373 (2000)

32. G. A. Thomas, D. A. Ackerman, P. R. Prucnal and S. Lance Cooper, "Physics in the Whirlwind of Optical Communications", Physics Today, 30-36, Sept. (2000).

33. V.V. Steblina, A.V. Bryak, R.A. Sammut, Deyu Zhou, M. Segev, and P. Prucnal, "Stable self-guided propagation of two optical harmonics coupled by a microwave of a terahertz wave", J. Opt. Soc. Am. B, 17, 2026 (2000).

34. H. Fang, R. Malendevich, R. Schiek and G. I. Stegeman, Measurement of Instability Gain Versus Periodicity in One-Dimensional $LiNbO_3$ Slab Waveguide, Phys. Rev. Lett., Vol 86, 4528-30 (2001)

35. Roman Malendevich, Ladislav Jankovic, George Stegeman and J. Stewart Aitchison, Spatial Modulation Instability in a Kerr Slab Waveguide, Opt. Lett., Vol 26, 1879-81 (2001).

36. Lluis Torner and George I. Stegeman, Multicolor Solitons, Opt. & Photon. News, Vol.12, 36-9 (2001).

37. Yuri S. Kivshar and George I. Stegeman, Spatial Optical Solitons: Guiding Light for Future Technologies, Opt. & Photon. News, Vol. 13, pp 26-30 (2002).

38. D. N. Christodoulides and E. Eugenieva, Blocking and Routing Discrete Solitons in Two-Dimensional Networks of Nonlinear Waveguide Arrays, Phys. Rev. Lett., vol. 87, pp. 233901, 2001.

39. D. N. Christodoulides and E. Eugenieva, Minimizing Bending Losses in Two-Dimensional Discrete Soliton Networks, Opt. Lett., vol. 26, pp. 1876, 2001.

40. E. D. Eugenieva, N. Efremidis, and D. N. Christodoulides, Design of Switching Junctions for Two-Dimensional Discrete Soliton Networks, Opt. Lett., vol. 26, pp. 1978, 2001.

41. E. D. Eugenieva, N. K. Efremidis, and D. N. Christodoulides, Navigating Discrete Solitons in Two-Dimensional Nonlinear Waveguide Array Networks, Optics and Photonics News, vol. 12, No. 12, pp. 57, 2001.

42. Z. H. Musslimani, M. Soljacic, M. Segev, and D. N. Christodoulides, Delayed-Action Interaction and Spin-Orbit Coupling Between Solitons, Phys. Rev. Lett., vol. 86, pp. 799, 2001.

43. D. N. Christodoulides, E. D. Eugenieva, T. H. Coskun, M. Segev, and M. Mitchell, On the Equivalence of Three Approaches Describing Partially Incoherent Wave Propagation in Inertial Nonlinear Media, Phys. Rev. E, vol. 63, pp. 035601, 2001.

44. D. Kip, C. Anastassiou, E. Eugenieva, D. Christodoulides, and M. Segev, Transmission of Images Through Highly Nonlinear Media Using Gradient-Index Lenses Formed by Incoherent Solitons, Opt. Lett., vol. 26, pp. 524, 2001.

45. Z. H. Musslimani, M. Soljacic, M. Segev, and D. N. Christodoulides, Interactions Between Two-Dimensional Composite Vector Solitons Carrying Topological Charges, Phys. Rev. E, vol. 63, pp. 066608, 2001.

46. C. Anastassiou, C. Pigier, M. Segev, D. Kip, E. Eugenieva, and D. N. Christodoulides, Self-Trapping of Bright Rings", Opt. Lett., vol. 26, pp. 911, 2001.

47. D. Kip, M. Soljacic, M. Segev, S. M. Sears, and D. N. Christodoulides, 1+1 Dimensional Modulational Instability of Spatially-Incoherent Light, J. of the Opt. Soc. of Am. B. xxxxxxxx

48. J. P. Torres, C. Anastassiou, M. Segev, M. Soljacic, and D. N. Christodoulides, Transverse Instability of Incoherent Solitons in Kerr Media, Phys. Rev. E, vol. 65, pp. 015601, 2001.

49. M. Segev and D. N. Christodoulides, Incoherent Solitons: Self-Trapping of Weakly-Correlated Wave-Packets, Optics and Photonics News, page 70, vol. 13, No. 2, 2002.

50. M. Soljacic and M. Segev, Integer and Fractional Angular Momentum Borne on Self-Trapped Necklace-Ring Beams, Phys. Rev. Lett. 86, 420 (2001).

51. T. Carmon, R. Uzdin, C. Pigier, Z. Musslimani, M. Segev, and A. Nepomnyashchy, Rotating Propeller Solitons, Phys. Rev. Lett. 87, 143901 (2001).

52. C. Anastassiou, J. W. Fleischer, T. Carmon, M. Segev, and K. Steiglitz, Information Transfer through Cascaded Collisions of Vector Solitons, Opt. Lett. 26, 1498 (2001).

53. C. Pigier, R. Uzdin, T. Carmon, M. Segev, A. Nepomnyashchy and Z. H. Musslimani, Collisions Between (2+1)D Rotating Propeller Solitons, Opt. Lett. 26, 1577 (2001).

54. J. C. Bronski, M. Segev, and M. I. Weinstein, Mathematical Frontiers in Optical Solitons, Invited Paper, Special Issue following the Frontiers of Science Symposium, Proceedings of the US National Academy of Science (PNAS) 98, 12872 (2001).

55. T. Carmon, R. Uzdin, C. Pigier, Z. Musslimani, M. Segev, and A. Nepomnyashchy, Rotating Propeller Solitons, Optics and Photonics News, Special Issue: Optics in 2001, vol. 12(12), 61 (2001).

56. M. Segev, Solitons: A Universal Phenomenon of Self-Trapped Wave Packets, Introduction by the feature Editor to the Special Issue of Optics and Photonics News on Optical Solitons, vol. 13(2), 27 (2002).

57. M. Segev and D. N. Christodoulides, Incoherent Solitons: Self-trapping of Weakly-Correlated Wave-Packets, Optics and Photonics News, Special Issue: Optical Solitons, vol. 13(2), 70 (2002).

58. R. Uzdin, M. Segev, and G. Salamo, Theory of Self-Focusing in Photorefractive InP, Opt. Lett. 26, 1547 (2001).

59. M. Segev and D. N. Christodoulides, Incoherent Solitons: Self-Trapping of Weakly-Correlated Wave-Packets, Optics and Photonics News, page 70, vol. 13, No. 2, 2002.

60. E. D. Eugenieva, N. K. Efremidis, and D. N. Christodoulides, Navigating Discrete Solitons in Two-Dimensional Nonlinear Waveguide Array Networks, Optics and Photonics News, vol. 12, No. 12, pp. 57, 2001.

61. M Klotz, M. Crosser, M. Henry, G. Salamo, M Segev, and G. Wood, Fixing Solitonic Y-Junctions in Photorefractive Strontium Barium Niobate, Opt. Lett., 26, 1274, 2001.

62. Yan-qing Lu, Min Xiao and Gregory J. Salamo, Wide-Bandwidth High-Frequency Electro-Optic Modulator Based on Periodically Poled $LiNbO_3$, Appl. Phys. Lett., 78,1035 (2001).

63. A. Guo, M. Henry, G. Salamo, M Segev, and G. Wood, Fixing Multiple Waveguides Induced by Photorefractive Solitons: Directional Couplers and Beam Splitters, Appl. Phys. Lett., 79, 1423, 2001.

64. Xiaodong Mu, Yujie J. Ding, Haeyeon Yang, and Gregory J. Salamo, Cavity-Enhanced and Quasi-Phase-Matched Multi-Order Reflection-Second-Harmonic Generation from GaAs/AlAs and GaAs/AlGaAs Multilayers, Appl. Phys. Lett., 79, 569, 2001.

65. Y. Berhane and M. O. Manasreh, H. Yang and G. J. Salamo, Thermal Annealing Effect on the Intersublevel Transitions in InAs Quantum Dots, Appl. Phys. Lett., 78, 2196, 2001.

66. Xiaodong Mu, Ioulia B. Zotova, Yujie J. Ding, Haeyeon Yang, and Gregory J. Salamo, Observation of Anomalously Large Blue Shift of Photoluminescence Peak and Evidence of Band-Gap Renormalization in InP/InAs/InP Quantum Wire, Appl. Phys. Lett., 79, 1091, 2001.

67. P. Ballet, J.B. Smathers, H. Yang, C. L. Workman and G.J. Salamo, Control of Size and Density of InAs/(Al, Ga)As Self-Organized Islands**,** J. of App. Phys., 90, 481, 2001.

68. B. C. Wang, V. Baby, W. Tong, L. Xu, M. Friedman, R. J. Runser, I. Glesk, and P. R. Prucnal, Novel Fast Optical Switch Based on Two Cascaded Terahertz Optical Asymmetric Demultiplexers (TOAD), Optics Express 10, 15 (2002).

69. L. Xu, B. C Wang, V. Baby, I. Glesk, and P. R. Prucnal, Optical Spectral Bistability in a Semiconductor Fiber Ring Laser through Gain Saturation in a SOA, IEEE Photon. Techn. Lett. 14, (2) 149-150 (2002).

70. B. C. Wang, L. Xu, V. Baby, D. Zhou, R. J. Runser, I. Glesk, and P. R. Prucnal, Experimental Study on the Regeneration Capability of the Terahertz Optical Asymmetric Demultiplexer, Opt. Comm. 199, 83-88 (2001).

71. B. Wang, I. Glesk, R. J. Runser, and P. R. Prucnal, Fast Tunable Parallel Optical Delay Line, Optics Express 8, (11) 559 (2001).

72. P. V. Studenkov, M. R. Gokhale, J. Wei, W. Lin, I. Glesk, P. R. Prucnal, and S. R Forrest, Monolithic, All-Optical Mach-Zehnder Demultiplexer Using an Asymmetric Twin Waveguide Structure, IEEE Photon. Techn. Lett., 13, 600 (2001).

73. I. Glesk, J. Runser, and P. R. Prucnal, New Generation of Devices for All-Optical Communications, Acta Physica Slovaca 51, (2) 151-162 (2001).

74. L. Xu, M. Yao, B. C. Wang, I. Glesk, and P. R. Prucnal, All-optical Clock Division with Mode-locked Figure-eight Laser Based on the Slow Carrier Recovery Rate in Semiconductor Optical Amplifier, IEEE Photon. Techn. Lett., 14, (3) 402-404 (2002).

75. V. M. Menon, W. Tong, C. Li, F. Xia, I. Glesk, P. R. Prucnal, and S. R. Forrest, “All-Optical Wavelength Conversion Using a Regrowth-Free Monolithically Integrated Sagnac Interferometer,” IEEE Photonics Technology Letters **15** (2) 254-256 (2003)

76. L. Xu, B. C. Wang, V. Baby, I. Glesk, P. R. Prucnal, "All-Optical Data Format Conversion Between RZ and NRZ Based on a Mach-Zehnder Interferometric Wavelength Converter," IEEE Photonics Technology Letters **15** (2) 308-310 (2003).

77. B. C. Wang, V. Baby, L. Xu, I. Glesk, and P. R. Prucnal,” 173-ps Wavelength Switching of Four DWM Channels Using an OTDM Channel Selector,” IEEE Photonics Technology Letters **14**, 11 620-622 (2002).

78. L. Xu, B. C. Wang, V. Baby, I. Glesk, and P. R. Prucnal, “Performance-improved All-optical RZ to NRZ Format Conversion Using Duplicator and Wavelength Converter,” Optics Communications **206** 77-80 (2002)

79. B. C. Wang, L. Xu, V. Baby, I. Glesk, and P. R. Prucnal, ‘State selection of a bistable SOA ring laser for bit level optical memory applications,” IEEE Photonics Technology Letters **14**, 989-991 (2002).

80. B. C. Wang, V. Baby, W. Tong, L. Xu, M. Friedman, R. J. Runser, I. Glesk, and P. R. Prucnal, “A novel fast optical switch based on two cascaded Terahertz Optical Asymmetric Demultiplexers (TOAD),” Optics Express **10**, 15 (2002).

81. L. Xu, M. Yao, B. C. Wang, I. Glesk, and P. R. Prucnal, “All-optical Clock Division with Mode-locked Figure-eight Laser Based on the Slow Carrier Recovery Rate in Semiconductor Optical Amplifier,” IEEE Photonics Technology Letters **14**, (3) 402-404 (2002)

82. L. Xu, B. C Wang, V. Baby, I. Glesk, and P. R. Prucnal, “Optical Spectral Bistability in a Semiconductor Fiber Ring Laser through Gain Saturation in a SOA,” IEEE Photonics Technology Letters **14**, (2) 149-150 (2002).

83. L. Friedrich, R. Malendevich, G. I. Stegeman, J. Soto-Crespo, N.N. Akhmediev, J. S. Aitchison, “Radiation Related Polarization Instability of Kerr Spatial Vector Solitons”, J. Opt. Soc. Am. B, Vol.19, 695-702 (2002)

84. Roman Malendevich, Ladislav Jankovic, Sergey Polyakov, Russell Fuerst, George Stegeman, Christian Bosshard and Peter Gunter, “Two-Dimensional Type I Quadratic Spatial Solitons in $KNbO_3$ Near Non-Critical Phase-Matching”, Opt. Lett., Vol. 27, 631-3 (2002)

85. Gaetano Assanto and George Stegeman, “The Simple Physics of Quadratic Spatial Solitons”, Optics Express, Vol 10, 388-96 (2002)

86. Sergey Polyakov, Roman Malendevich, Ladislav Jankovic, George Stegeman, Christian Bosshard and Peter Gunter, “Effects of Anisotropic Diffraction on Quadratic Multi Soliton Excitation in Non-critically Phase-matched Crystals”, Opt. Lett., Vol. 27, 1049-51 (2002)

87. Silvia Carrasco, Hongki Kim, George Stegeman and Lluis Torner, “Observation of self-focusing of light mediated by cubic nonlinearities in potassium titanyl phosphate”, Opt. Lett., Vol. 27, 2016-8 (2002)

88. Hongki Kim, Ladislav Jankovic, George I. Stegeman, Mordechai Katz, Silvia Carrasco and Lluis Torner, “Second Harmonic Generation Tuning Curves with Narrow, High Intensity Beams For Quasi-Phase-Matched KTP”, Appl. Phys. Lett., Vol. 81, 2710-12 (2002)

89. Sergey V. Polyakov and George I. Stegeman, “Existence and Properties of Quadratic Solitons in Anisotropic Media: Variational Approach”, Phys. Rev. E, Vol. 66, 046622-1 to 7 (2002)

90. George I. Stegeman, Roland Schiek, Hui Fang, Roman Malendevich, Ladislav Jankovic, Lluis Torner, Wolfgang Sohler and Gerhard Schreiber, “Beam Evolution in Quadratically Nonlinear 1-Dimensional Media: LiNbO3 Slab Waveguides”, Laser Physics, Vol. 13, 137–147 (2003).

91. E. Ultanir, D. Michaelis, F. Lederer and G. I. Stegeman, “Stable Spatial Solitons in Semiconductor Optical Amplifiers”, Opt. Lett., 28:251-3 (2003)

92. Yu. I. Mazur, X. Wang, Z. M. Wang, M. Xiao, G. J. Salamo, “Photoluminescence study of carrier transfer among vertically aligned double-stacked InAs/GaAs quantum dot layers” Appl. Phys. Lett. Vol. 81, 2469 (2002).

93. Z. M. Wang, V. R. Yazdanpanah, J. L. Shultz, and G. J. Salamo, “GaAs(311) templates for molecular beam epitaxy growth: surface morphologies and reconstruction” Appl. Phys. Lett. Vol. 81, 2965 (2002).

94. Y. Berhane, M. O. Manasreh, H. Yang, and G. J. Salamo, “Response to “Thermal Annealing Efect on the Intersublevel Transitions in InAs Quantum Dots”, Appl. Phys. Lett. Vol. 80, 4869-4870 (2002).

95. X. Mu, Y. J. Ding, H. Yang, and G. J. Salamo, “Vertically stacking self-assembled quantum wires”, Appl. Phys. Lett., Vol. 81, pp. 1107-1109, Aug. 5, 2002.

96. Z. M. Wang, V. R. Yazdanpanah, C. L. Workman, W. Q. Ma, J. L. Shultz, and G. J. Salamo, “Origin of step formation on the GaAs(311) surface” Phys. Rev. Vol. B 66, 1933 (2002).

97. H. Yang, X. Mu, I. B. Zotova, Y. J. Ding, and G. J. Salamo, “Self-assembled InAs quantum wires on InP(001)”, Journal of Applied Physics., Vol. 91, pp. 3925-3927, 2002.

98. H. Yang, X. Mu, I. B. Zotova, Y. J. Ding, and G. J. Salamo, “Self-assembled InAs quantum wires on InP(001)”, Journal of Applied Physics, Vol. 91, 3925, 2002

99. Y. Lu, Min Xiao, and G.J. Salamo, “Coherent Microwave Generation in Nonlinear Photonic Crystal”, IEEE, J. of Quantum Electronics, Vol. 38, 481 (2002).

100. J. W. Fleischer, M. Segev, N. K. Efremidis, and D. N. Christodoulides, “Observation of two-dimensional discrete solitons in optically-induced nonlinear photonic lattices”, Nature, vol. 422, pp. 147, (2003).

101. J. W. Fleischer, T. Carmon, M. Segev, N. K. Efremidis, and D. N. Christodoulides, “Observation of discrete solitons in optically-induced real-time waveguide arrays” Physical Review Letters, vol. 90, pp. 023902, (2003).

102. Z. Chen, S. Sears, H. Martin, D. N. Christodoulides, and M. Segev, “Clustering of solitons in weakly correlated wavefronts”, Proceedings of the National Academy of Sciences (USA), vol. 99, pp. 5223, (2002).

103. D. Kip, M. Soljacic, M. Segev, S. M. Sears, and D. N. Christodoulides, “1+1 Dimensional modulational instability of spatially-incoherent light”, Journal of the Optical Society of America B, vol. 19, pp. 502, (2002).

104. S. M. Sears, M. Soljacic, D. N. Christodoulides, and M. Segev, “Pattern formation via symmetry breaking in nonlinear weakly-correlated systems”, Physical Review E, vol. 65, pp. 036620, (2002).

105. D. N. Christodoulides and N. K. Efremidis, “Discrete temporal solitons along a chain of nonlinear coupled microcavities embedded in photonic crystals”, Optics Letters, vol. 27, pp. 568, (2002).

106. N. K. Efremidis and D. N. Christodoulides, “Discrete solitons in nonlinear zigzag optical waveguide arrays with tailored diffraction properties”, Physical Review E, vol. 65, pp. 056607, (2002).

107. N. K. Efremidis, S. Sears, D. N. Christodoulides, J. W. Fleischer, and M. Segev, “Discrete solitons in photorefractive optically-induced photonic lattices”, Physical Review E, vol. 66, pp. 046602 (2002).

108. Z. Chen, J. Klinger, and D. N. Christodoulides, “Induced modulation instability of partially spatially incoherent light with varying perturbation periods”, Physical Review E, vol. 66, pp. 066601 (2002).

109. N. K. Efremidis and D. N. Christodoulides, “Discrete Ginzburg-Landau solitons”, Physical Review E, vol. 67, pp. 026606, (2003).

110. J. Hudock, P. G. Kevrekidis, B. A. Malomed, and D. N. Christodoulides, “Discrete vector solitons in two-dimensional nonlinear waveguide arrays:solutions, stability and dynamics”, Physical Review E (in print).

111. J. P. Torres, L. Torner, I. Biaggio, and M. Segev, “Tunable self-action of light in optical rectification”, Optics Communications 213, 351 (2002).

112. O. Cohen, T. Carmon, M. Segev, and S. Odoulov, “Holographic solitons”, Optics Letters 27, 2031 (2002).

113. O. Cohen, S. Lan, T. Carmon, J. A. Giordmaine, and M. Segev, “Spatial vector solitons consisting of counter-propagating fields, Optics Letters 27, 2013 (2002).

114. T. Carmon, M. Soljacic, and M. Segev, Pattern formation in a cavity longer than the coherence length of the light in it”, Physical Review Letters 89, 183902 (2002).

115. O. Cohen, R. Uzdin, T. Carmon, J. W. Fleischer, M. Segev and S. Odoulov, “Collisions between optical spatial solitons propagating in opposite directions”, Physical Review Letters 89, 133901 (2002).

116. H. Buljan,, A. Siber, M. Soljacic, and M. Segev, “Propagation of incoherent “white” light and modulation instability in non-instantaneous nonlinear media”, Physical Review E, Rapid Communication, 66, 35601 (2002).

117. T. Schwartz, Y. Ganor, T. Carmon, R. Uzdin, S. Schwartz, M. Segev and U. El-Hanany, “Photorefractive solitons and light-induced resonance control in CdZnTe”, Optics Letters 27, 1229 (2002).

118. S. Lan, J. A. Giordmaine, M. Segev and D. Rytz, “Optical parametric oscillation in soliton-induced waveguides”, Optics Letters 27, 737 (2002).

119. George I. Stegeman, Roland Schiek, Hui Fang, Roman Malendevich, Ladislav Jankovic, Lluis Torner, Wolfgang Sohler and Gerhard Schreiber, “Beam Evolution in Quadratically Nonlinear 1-Dimensional Media: $LiNbO_3$ Slab Waveguides”, Laser Physics, 13:137–147 (2003).

120. Hongki Kim, Ladislav Jankovic, George Stegeman, Silvia Carrasco, Lluis Torner, David Eger and Mordechai Katz, “Quadratic Spatial Solitons in Periodically Poled $KTiOPO_4$”, Opt. Lett., 28:640-2 (2003)

121. Hongki Kim, Ladislav Jankovic, George Stegeman, Silvia Carrasco, Lluis Torner, Mordechai Katz and David Eger, “Second Harmonic Generation, Beam Dynamics and Spatial Soliton Generation in Periodically Poled $KTiOPO_4$ (PPKTP)”, Acta Physica Polonica, 103:107-120 (2003)

122. Silvia Carrasco, Sergey Polyakov, Hongki Kim, Ladislav Jankovic, George I. Stegeman, Juan P. Torres, Lluis Torner, and Mordechai Katz, “Observation of multiple soliton generation mediated by amplification of asymmetries”, Phys. Rev. E, **67:** 046616-1 (2003)

123. Mordechai Katz, David Eger, Hongki Kim, Ladislav Jankovic, George Stegeman, Silvia Carrasco and Lluis Torner, “Second Harmonic Generation Tuning Curves In Quasi-Phase-Matched KTP With Narrow, High Intensity Beams”, J. Appl. Phys., 93:8852-8861 (2003).

124. Sergey Polyakov, Ladislav Jankovic, Hongki Kim, George Stegeman, Silvia Carrasco, Lluis Torner and Mordechai Katz, “Properties of Quadratic Multi-Soliton Generation Near Phase-Match in Periodically Poled Potassium Titanyl Phosphate”, Opt. Express, 11:1328-37 (2003)

125. Ladislav Jankovic, Hongki Kim, Sergey Polyakov, George I. Stegeman, Christian Bosshard and Peter Gunter, ‘Soliton Birth In Quadratic Spatial Soliton Collisions’, Opt. Lett., 28:1037-9 (2003)

126. Erdem A. Ultanir, George I. Stegeman, Dirk Michaelis, Falk Lederer, and Christoph Lange, “Stable Dissipative Spatial Solitons in Semiconductor Optical Amplifiers”, Phys. Rev. Lett., 90(25):3903 (2003)

127. Sergey Polyakov, Hongki Kim, Ladislav Jankovic, George Stegeman, and Mordechai Katz, "Weak Beam Control of Multi-Quadratic-Soliton-Generation", Opt. Lett., 28:1451-3 (2003)

128. Ladislav Jankovic, Hongki Kim, George Stegeman, Silvia Carrasco, Lluis Torner and Mordechai Katz, "Quadratic Soliton Self-Reflection At A Quadratically Nonlinear Interface", Opt. Lett., 28:2103-5 (2003)

129. L. Jankovic, S. Polyakov, G. Stegeman, S. Carrasco, L. Torner, C. Bosshard, and P. Gunter, "Complex soliton-like pattern generation in Potassium Niobate due to noisy, high intensity, input beams," Opt. Express **11,** 2206-2210 (2003)

130. Joachim Meier, Jared Hudock, Demetrios Christodoulides, George Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "Discrete Vector Solitons in Kerr Nonlinear Waveguide Arrays", Phys. Rev. Lett., 91: 143907 (2003)

131. George I. Stegeman, Ladislav Jankovic, Hongki Kim, Sergey Polyakov, Silvia Carrasco, Lluis Torner, Christian Bosshard, Peter Gunter, Mordechai Katz and David Eger, "Generation of, and Interactions Between Quadratic Spatial Solitons in Non-Critically-Phase-Matched Crystals", Journal of Nonlinear Optical Physics & Materials, **12** (4), 447-466, (2003)

132. Erdem A. Ultanir, George I. Stegeman, Christoph H. Lange, and Falk Lederer, "Interactions of Dissipative Spatial Solitons", Opt. Lett., 29:283-5 (2004)

133. N. K. Efremidis and D. N. Christodoulides, "Discrete Ginzburg-Landau solitons", Physical Review E, vol. 67, pp. 026606, (2003).

134. J. Hudock, P. G. Kevrekidis, B. A. Malomed, and D. N. Christodoulides, "Discrete vector solitons in two-dimensional nonlinear waveguide arrays: solutions, stability and dynamics", Physical Review E, vol. 67, pp. 056618 (2003).

135. H. Buljan, M. Segev, M. Soljacic, N. K. Efremidis, and D. N. Christodoulides, "White light solitons", Optics Letters, vol. 28, pp. 1239, (2003).

136. N. K. Efremidis and D. N. Christodoulides, "Lattice solitons in Bose-Einstein condensates", Physical Review A, vol. 67, pp. 063608, (2003).

137. D. N. Christodoulides, F. Lederer, and Y. Silberberg, "Discretizing light behavior in linear and nonlinear waveguide lattices", Nature, vol. 424, pp. 817, 2003.

138. Z. Chen, M. Segev, and D. N. Christodoulides, "Experiments on partially coherent photorefractive solitons", Journal of Optics A: Pure and Applied Optics, vol. 5, pp. S389, (2003).

139. O. Cohen, T. Schwartz, J. W. Fleischer, M. Segev, and D. N. Christodoulides, "Multi-band vector lattice solitons", Physical Review Letters, vol. 91, pp. 113901 , (2003).

140. B. Freedman, T. Carmon, M. I. Carvalho, M. Segev, and D. N. Christodoulides, “Observation of locked optical kink-antikink spatial shock-waves”, Physical Review Letters, vol. 91, pp. 133902, (2003).

141. H. Buljan, A. Siber, M. Soljacic, T. Schwartz, M. Segev, and D. N. Christodoulides, “Incoherent white solitons in logarithmically saturable non instantaneous nonlinear media”, Physical Review E, vol. 68, pp. 036607, (2003).

142. N. K. Efremidis, J. Hudock, D. N. Christodoulides, J. W. Fleischer, O. Cohen, and M. Segev, “Two-dimensional optical lattice solitons”, Physical Review Letters, vol. 91, pp. 213906, (2003).

143. J. Hudock, N. K. Efremidis, and D. N. Christodoulides, “Anisotropic diffraction and elliptic discrete solitons in two-dimensional waveguide arrays”, Optics Letters, vol. 29, pp. 268, (2003).

144. M. Soljacic, K. Steiglitz, S. M. Sears, M. Segev, M. H. Jakubowski, and R. Squier, “Collisions of two solitons in an arbitrary number of coupled nonlinear Schrodinger equations”, Physical Review Letters 90, 254102 (2003).

145. H. Buljan, M. Soljacic, T. Carmon, and M. Segev, “Cavity pattern formation with incoherent light”, Physical Review E 68, 016616 (2003).

146. Lei Xu, Ivan Glesk, Darren Rand, Varghese Baby, Paul Prucnal, “Suppression of beating noise of narrow linewidth Erbium doped fiber ring lasers using SOA” Optics Letters 28:780-2 (2003). (Reported by Photonics Spectra, (Photonics Research), “Eliminating beat noise in ring lasers,” by Breck Hitz. Page 104-106. July, 2003)

147. V. M. Menon, W. Tong, C. Li, F. Xia, I. Glesk, P. R. Prucnal, and S. R. Forrest, “All-Optical Wavelength Conversion Using a Regrowth-Free Monolithically Integrated Sagnac Interferometer,” IEEE Photonics Technology Letters 15:254-6 (2003).

148. V. Baby, B. C. Wang, L. Xu, I. Glesk, and P. R. Prucnal, “Highly scalable serial-parallel optical delay line” Optics Communications 218: 235-242 (2003).

149. I. Glesk, L. Xu, D. Rand, and P. R. Prucnal, “Wavelength tunable semiconductor fiber ring laser through electro-optical polarization control” Acta Physica Slovaca 53: 413-416 (2003).

150. L. Xu, B. C. Wang, V. Baby, I. Glesk, P. R. Prucnal, "All-Optical Data Format Conversion Between RZ and NRZ Based on a Mach-Zehnder Interferometric Wavelength Converter" IEEE Photonics Technology Letters 15: 308-310 (2003).

151. B. Pattada, J Chen, Q Zhou, M.O. Manasreh, M.L. Hussein, W. Ma, and G.J. Salamo, “Optical absorption of intersubband transitions in InGaAs/GaAs multiple quantum dots”, Appl. Phys. Lett. 82, 2509 (2003).

152. M.O. Manasreh, D.J. Friedman, W. Ma, C.L. Workman, C.E. George, and G.J. Salamo, “Photoluminescence of metalorganic chemical vapor deposition grown GaInNAs/GaAs”, Appl. Phys. Lett. 82, 2509 (2003).

153. V. R. Yazdanpanah, Z. M. Wang, and G. J. Salamo, "Highly anisotropic morphologies of GaAs (331) surfaces" Appl. Phys. Lett. 82, 514 (2003).

154. W.Q.Ma, X. Wang, Z. M. Wang, M. L. Hussein, J. Shultz, M. Xiao, and G. J. Salamo, “Piezoelectric effect in elongated (In,Ga)As islands on GaAs(100)” Phys. Rev. B 67, 035315-1 (2003).

155. Yu. I. Mazur, W.Q.Ma, Z. M. Wang, G. J. Salamo, and M. Xiao, "InGaAs/GaAs three-dimensionally-ordered array of quantum dots" Appl. Phys. Lett. 83, 987 (2003).

156. Yu. I. Mazur, W.Q.Ma, Z. M. Wang, G. J. Salamo, and M. Xiao, “Hidden resonant excitation of photoluminescence in bilayer arrays of InAs/GaAs quantum dots” Appl. Phys. Lett. 83, 1866 (2003).

157. Z. M. Wang, V. R. Yazdanpanah, J. L. Shultz, and G. J. Salamo, "Strain-driven facet formation on self-assembled InAs Islands on GaAs (311) A" Appl. Phys. Lett. 82, 1688 (2003).

158. Z. M. Wang, J. L. Shultz, and G. J. Salamo, “Morphology evolution during strained (In,Ga) epitaxial growth on GaAs vicinal (100) surfaces”, Appl. Phys. Lett. 83, 1749 (2003).

159. Z. M. Wang, and G. J. Salamo, "Surface dynamics during phase transitions of GaAs (100)" Phys. Rev. B 67, 125324-1 (2003).

160. X.Y.Wang, Z.M.Wang, V.R.Yazdanpanah, M.Xiao and G.J.Salamo, “Polarization spectroscopy of InGaAs/GaAs quantum wires grown on (331)B GaAs template with nanoscale fluctuations”J. Appl. Phys. 95, 1609 (2004).

161. Silvia Carrasco, Dmitri V. Petrov, Juan P. Torres, Lluis Torner, Hongki Kim, George Stegeman and J. J. Zondy, “Observation of self-trapping of light in walk-off compensating Tandems”, Opt. Lett., 29:382-4 (2004)

162. R. Schiek, R. Iwanow, G. I. Stegeman, G. Schreiber, and W. Sohler “One-Dimensional Spatial Soliton Families in Optimally Engineered QPM Lithium Niobate Waveguides”, Opt. Lett., 29:596-8 (2004)

163. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, G. Salamo and J.S. Aitchison, “Experimental Observation of Discrete Modulational Instability”, Phys. Rev. Lett., 92:1639021-4, (2004)

164. Sergey Polyakov, Fumiyo Yoshino , Mingguo Liu and George Stegeman, “Nonlinear Refraction and Multiphoton Absorption in Polydiacetylenes From 1200 To 2200 nm”, Phys. Rev. B, 69:1154211-11 (2004)

165. Erdem A. Ultanir, George I. Stegeman, Demetrios N. Christodoulides, “Dissipative Photonic Lattice Solitons”, Opt. Lett., 29: 845-8 (2004)

166. Ladislav Jankovic, Hongki Kim, Sergey Polyakov, George I. Stegeman, Christian Bosshard and Peter Gunter, “Interactions of Quadratic Spatial Solitons in Non-Critically-Phase-Matched $KNbO_3$”, Laser Physics, 14:264-72 (2004)

167. Joachim Meier, George I. Stegeman, Y. Silberberg, R. Morandotti and J.S. Aitchison, “Nonlinear Optical Beam Interactions In Waveguide Arrays”, Phys. Rev. Lett., 93:939031-4 (2004)

168. X.Y.Wang, Z.M.Wang, V.R.Yazdanpanah, M.Xiao and G.J.Salamo, “Polarization spectroscopy of InGaAs/GaAs quantum wires grown on (331)B GaAs template with nanoscale fluctuations”, J. Appl. Phys. 95: 1609 (2004).

169. Z.M.Wang, K. Holmes, Yu. I. Mazur, and G.J.Salamo, “Fabrication of (In,Ga)As quantum-dot chains on GaAs(100)”Appl. Phys. Lett. 84: 1931 (2004).

170. H.Wen, Z.M.Wang, and G.J.Salamo, “Atom-resolved scanning tunneling microscopy of (In,Ga)As quatnum wires on GaAs(311)A” Appl. Phys. Lett. 84: 1756, (2004).

171. Z. M. Wang, Yu. I. Mazur, G. J. Salamo, P. M. Lytvin, V. V. Strelchuk, and M. Ya. Valakh , “Persistence of (In,Ga)As quantum-dot chains under index deviation from GaAs(100)”, Appl. Phys. Lett. 84: 4681 (2004).

172. Ying Chao Chua, E. A. Decuir, Jr., B. S. Passmore, K. H. Sharif, M. O. Manasreh, Z. M. Wang, and G. J. Salamo, “Tuning In[sub 0.3]Ga[sub 0.7]As/GaAs multiple quantum dots for long-wavelength infrared detectors”, Appl. Phys. Lett. 85: 1003 (2004).

173. J. W. Fleischer, G. Bartal, O. Cohen, O. Manela, M. Segev, J. Hudock, and D. N. Christodoulides, “Observation of vortex-ring solitons in 2D photonic lattices”, Phys. Rev. Lett., 92: 123904 (2004).

174. K. Hizanidis, S. Droulias, I. Tsopelas, N. K. Efremidis, and D. N. Christodoulides, “Centrally coupled circular array of optical waveguides: the existence of stable steady state continuous waves and breathing modes”, Physica Scripta, T107:13 (2004)..

175. H. Martin, E. Eugenieva, Z. Chen, and D. N. Christodoulides, “Soliton-induced dislocations and discrete solitons in partially-coherent photonic lattices”, Phys. Rev. Lett., 92: 123902 (2004).

176. O. Katz, T. Carmon, T. Schwartz, M. Segev, and D. N. Christodoulides, "Observation of elliptic incoherent spatial solitons", Opt. Lett., 29: 1248 (2004).

177. D. N. Christodoulides, N. K. Efremidis, P. Di. Trapani, B. A. Malomed, "Bessel-X-waves in two- and three-dimensional bidispersive optical systems", Opt. Lett., 29:1446 (2004).

178. H. Buljan, O. Cohen, J.W. Fleischer, T. Schwartz, M. Segev , Z.H. Musslimani, N. K. Efremidis, and D.N. Christodoulides, "Random phase solitons in nonlinear periodic lattices", Phys. Rev. Lett., 92: 223901 (2004).

179. Y. V. Kartashov, A. Egorov, L. Torner, and D. N. Christodoulides, "Stable soliton complexes in two-dimensional photonic lattices", Opt. Lett., 29: 1918 (2004).

180. Robert Iwanow, Roland Schiek, George Stegeman, Thomas Pertsch, Falk Lederer, Yoohong Min and Wolfgang Sohler**, "**Observation of Discrete Quadratic Solitons**",** Phys. Rev. Lett., 113902 (2004)

181. Ladislav Jankovic, Pierre Aboussouan , Marco Affolter, George I. Stegeman and Mordechai Katz, "Quadratic Soliton Collisions", Opt. Express, 12(22): 5562-76 (2004)

182. J. Meier, G.I. Stegeman, D.N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "Observation of discrete modulational instability", Opt. & Phot. News, 15, 31 (2004)

183. T. Pertsch, R. Iwanow, R. Schiek, G. Stegeman, U. Peschel, F. Lederer, Y. H. Min and W. Sohler, "Spatial ultrafast switching and frequency conversion in lithium niobate waveguide arrays", Opt. Lett., 30(2): 177-9 (2005)

184. E. A. Ultanir, G. I. Stegeman and C. H. Lange, "Stability Properties of Multi-Wavelength, Incoherent, Dissipative, Spatial Solitons", Opt. Lett., 30:531-4 (2005)

185. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "Beam Interactions With a "Blocker" Soliton in 1D Arrays", Opt. Lett., 30:1027-9 (2005)

186. Robert Iwanow, George I. Stegeman, Roland Schiek, Tomas Pertsch, Falk Lederer, Yoohong Min and Wolfgang Sohler, " Highly Localized Discrete Quadratic Solitons in Periodically Poled Lithium Niobate Waveguide Arrays", Opt. Lett., 30:1033-5 (2005)

187. J. Meier, G. I. Stegeman, D. N. Christodoulides, R. Morandotti, M. Sorel, H. Yang, G. Salamo and J. S. Aitchison, "Nonlinear Beam Interactions in 1D Discrete Kerr Systems", Opt. Expr, 13:1798-1807 (2005).

188. R. Schiek, R. Iwanow, G. Stegeman, T. Pertsch, F. Lederer, Y. H. Min and W. Sohler, "Low power multiport ultrafast parametric switching in cascaded waveguide couplers", Appl. Phys. Lett., 87: 011109, pages1-3 (2005)

189. S. Droulias, K. Hizanidis, J. Meier and D. N. Christodoulides, “X – waves in nonlinear normally dispersive waveguide arrays”, Opt. Express, **13,** 1827-32 (2005)

190. J. Meier, J. Hudock, D. N. Christodoulides and G. I. Stegeman, H. Yang, G. Salamo, R. Morandotti, J. S. Aitchison and Y. Silberberg, “Excitation of Strongly Confined Scalar and Vector Self-Trapped Beams in One Dimensional Arrays of Kerr-Nonlinear Channel Waveguides”, JOSA B, **22**, 1432-6 (2005).

191. Robert Iwanow, Roland Schiek, George Stegeman, Thomas Pertsch, Falk Lederer Yoohong Min and Wolfgang Sohler, “Arrays of weakly coupled, periodically poled lithium niobate waveguide arrays: beam propagation and discrete spatial quadratic solitons”, Journal of Optoelectronics Review, 13:113-121 (2005)

192. J. Meier, D. Christodoulides, G. I. Stegeman, H. Yang, G. Salamo, R. Morendotti, J. S. Aitchison and Y. Silberberg, “Wide Beam Stabilities and Instabilities in One Dimensional Arrays of Kerr-Nonlinear Channel Waveguides”, Journal of Optoelectronics Review, 13: 75-84 (2005)

193. Robert Iwanow, Daniel A. May-Arrioja, Demetrios N. Christodoulides, George I. Stegeman, Yoohong Min and Wolfgang Sohler, “Discrete Talbot Effect”, Phys. Rev. Lett., 95: 053902 (2005)

194. Konstantinos G. Makris, Sergiy Suntsov, Demetrios N. Christodoulides, and George I. Stegeman “Discrete surface solitons”, Opt. Lett., 2466-8, (2005)

195. O. Cohen, B. Freedman, J. W. Fleischer, M. Segev, and D. N. Christodoulides, “Grating mediated waveguiding”, Physical Review Letters, **93**, 103902 (2004).

196. N. K. Efremidis and D. N. Christodoulides, “Bloch oscillations in optical dissipative lattices”, Optics Letters, **29**, 2485, (2004).

197. J. W. Fleischer, D. N. Neshev, G. Bartal, T. J. Alexander, O. Cohen, E. Ostrovskaya, O. Manela, H. Martin, J. Hudock, I. Makasyuk, Z. Chen, D. N. Christodoulides, Y. Kivshar, and M. Segev, “Observation of discrete vortex solitons in 2D photonic lattices”, Optics in 2004, Optics and Photonics News, page 30, December 2004.

198. R. Morandotti, D. Mandelik, Y. Silberberg, S. Aitchison, M. Sorel, D. N. Christodoulides, A. Sukhorukov, and Y. Kivshar, “Observation of discrete gap solitons in binary waveguide arrays”, Optics Letters, **29**, 2890 (2004).

199. N. K. Efremidis and D. N. Christodoulides, “Revivals in engineered waveguide arrays”, Optics Communications, **246**, 345, (2005).

200. O. Cohen, J. Fleischer, G. Bartal, H. Buljan, T. Carmon, M. Segev, and D. N. Christodoulides, “Observation of random-phase lattice solitons”, Nature, **433**, 500, (2005).

201. K. G. Makris, H. Sarkissian, D. N. Christodoulides, and G. Assanto, “Nonlocal incoherent spatial solitons in liquid crystals”, Journal of Optical Society of America B, **22**, 1371, (2005).

202. B. Freedman, O. Cohen, O. Manela, M. Segev, J. W. Fleischer, and D. N. Christodoulides, “Grating –mediated waveguiding and holographic solitons”, Journal of Optical Society of America B, **22**, 1349, (2005).

203. Y. V. Kartashov, L. Torner, and D. N. Christodoulides, “Soliton dragging by dynamic optical lattices”, Optics Letters, **30**, 1378 (2005).

204. Z. Chen, H. Martin, A. Bezryadina, D. Neshev, Y. Kivshar, and D. N. Christodoulides, “Experiments on Gaussian beams and vortices in optically-induced photonic lattices”, Journal of Optical Society of America B, **22**, 1395, (2005).

205. H. Buljan, G. Bartal, O. Cohen, J. W. Fleischer, T. Schwartz, O. Manela, T. Carmon, M. Segev, and D.N. Christodoulides, “Partially coherent waves in nonlinear periodic lattices”, Studies in Applied Mathematics, **115**, 173, (2005).

206. I. Glesk, V. Baby, C.-S. Brès, L. Xu, D. Rand, P. R. Prucnal, “Experimental demonstration of 2.5 Gbit/s incoherent two dimensional optical code division multiple access system,” Acta Physica Slovaca **54**, 3, 245-250, (2004).

207. D. Rand, K. Steiglitz, P. R. Prucnal, “Signal standardization in collision-based soliton computing,” International Journal of Unconventional Computing **1**, 31-45, (2005).

208. D. Rand, K. Steiglitz, P. R. Prucnal, “Quantum theory of Manakov solitons,” Phys. Rev. A **71**, 053805 (2005).

209. D. Rand, K. Steiglitz, P. R. Prucnal, “Multicomponent gap solitons in superposed grating structures,” Opt. Lett. **30**, 1695-1697 (2005).

210. T. Schwartz, T. Carmon, H. Buljan, and M. Segev, “Spontaneous pattern formation with incoherent “white” light”, Phys. Rev. Lett. **93**, 223901 (2004).

211. T. Schwartz, J.W. Fleischer, T. Carmon, O. Cohen, H. Buljan, and M. Segev, “Pattern formation in a ring cavity with a temporally-incoherent feedback”, the J. Opt. Soc. Am. **21**, 2197 (2004).

212. O. Manela, O. Cohen, G. Bartal, J.W. Fleischer, and M. Segev, “Two-dimensional higher-band vortex lattice solitons”, Opt. Lett. 29, 2049 (2004).

213. T. Carmon, H. Buljan, and M. Segev, Spontaneous pattern formation in a cavity with incoherent light, Optics Express 12, 3481 (2004).

214. C. Rotschild, O. Cohen, O. Manela, T. Carmon, and M. Segev, “Interactions between spatial screening solitons propagating in opposite directions”, J. Opt. Soc. Am. B 21, 1354 (2004).

215. J.W. Fleischer, G. Bartal, O. Cohen, T. Schwartz, O. Manela, B. Freedman, M. Segev, H. Buljan, and N.K. Efremidis, “Spatial photonics in nonlinear waveguide arrays”, Opt. Exp. 13, 1780 (2005).

216. V. Coda, R. D. Swain, H. Maillotte, M. Chauvet and G. J. Salamo “Wavelength, power and pulse duration influence on spatial soliton formation in AlGaAs”, Optics Communications **251,** 186-193, 2005

217. Yu. I. Mazur, Zh. M. Wang, G. G. Tarasov, G. J. Salamo, J. W. Tomm, V. Talalaev, and H. Kissel "Nonresonant tunneling carrier transfer in bilayer asymmetric InAs/GaAs quantum dots" Physics Review B **71**, 235313 (2005).

218. V.R. Yazdanpanah, Zh.M. Wang, and G.J. Salamo "Morphological instability of GaAs (7 1 1)A: A transition between (1 0 0) and (5 1 1) terraces" Journal of Crystal Growth 280, **2** (2005).

219. D. Grigoriev, M. Schmidbauer, P. Schafer, S. Besedin, Yu. I. Mazur, Zh. M. Wang, G. J. Salamo, and R. Kohler "Three-dimensional self-ordering in an InGaAs/GaAs multilayered quantum dot structure investigated by x-ray diffuse scattering" J. Phys. D: Appl. Phys. **38**, A154-A159 (2005).

220. Z. M. Wang, K. Holmes, J. L. Shultz, and G. J. Salamo "Self-assembly of GaAs holed nanostructures by droplet epitaxy" Phys. Stat. Sol. (a) **202**, R85 R87 (2005).

221. Zh. M. Wang, Sh. Seydmohamadi, V. R. Yazdanpanah, and G. J. Salamo "Surface dynamics during molecular-beam epitaxy of (In,Ga)As on GaAs(331)B: Formation of quantum wires with low In content" Physics Review B **71**, 165315 (2005).

222. V.R. Yazdanpanah, Zh.M. Wang, Sh. Seydmohamadi, and G.J. Salamo "RHEED study of GaAs(3 3 1)B surface" Journal of Crystal Growth **277**, 72 (2005).

223. Sh. Seydmohamadi, Zh. M. Wang, G. J. Salamo "Orientation dependence behavior of self-assembled (In,Ga)As quantum structures on GaAs surface" Journal of Crystal Growth 275, 410 (2005).

224. Zh. M. Wang, L. Zhang, K. Holmes, and G. J. Salamo "Selective etching of InGaAs/GaAs(100) multilayers of quantum-dot chains" Applied Physics Letters **86**, 143106 (2005).

225. Xiaodong Mu, Yujie J. Ding, Zhiming Wang, and G. J. Salamo "Evidence of Strong Phonon-Assisted Resonant Intervalley Up-Transfer for Electrons in Type-II GaAsAlAs Superlattices" IEEE J. Quantum Electronics **41**, 337 (2005).

226. S. O. Cho, Zh. M. Wang, and G. J. Salamo "Evolution Of Elongated (In,Ga)As/GaAs(100) Island with Low Indium Content" Applied Physics Letters **86**, 113106 (2005).

227. Yu. I. Mazur, Zh. M. Wang, G. G. Tarasov, M. Xiao, G. J. Salamo, J. W. Tomm, V. Talalaev, and H. Kissel "Interdot carrier transfer in asymmetric bilayer InAs/GaAs quantum dot structures" Applied Physics Letters **86**, 63102 (2005).

228. M.Ya. Valakh, V.V. Strelchuk, A.F. Kolomys, Yu.I. Mazur, Z.M. Wang, M. Xiao, and G.J. Salamo Resonant Raman Scattering and Atomic Force Microscopy of InGaAs/GaAs Multilayer Nanostructures with Quantum Dots" Semiconductors **39**, 127-131 (2005).

229. X. Mu, Y. J. Ding, Zhiming Wang, and G. J. Salamo, "Phonon-Assisted Up-Transfer for Electrons in Type-II GaAs/AlAs Superlattices" Laser Physics **15**, 225-232 (2005).

230. Bo-Kuai Lai, Igor A. Kornev, L. Bellaiche and G. J. Salamo, ``Phase Diagrams of Epitaxial BaTiO3 Ultrathin Films from First Principles," Applied Physics Letters **86**, 132904 (2005).

231. J. Meier, G. I. Stegeman, D. N. Christodoulides, R. Morandotti, H. Yang, G. Salamo, M. Sorel, Y. Silberberg and J.S. Aitchison, "Incoherent Blocker Soliton Interactions in Kerr Waveguide Arrays", Opt. Lett., **30**, 3174-3176 (2005)

232. Robert Iwanow, Roland Schiek, George Stegeman, Yoohong Min and Wolfgang Sohler, "Discrete Modulational Instability in Periodically Poled Lithium Niobate Waveguide Arrays", Optics Express, **13**, 7794-99 (2005)

233. Jared Hudock, Sergiy Suntsov, Demetrios N. Christodoulides, and George I. Stegeman , "Vector discrete surface waves", Opt. Express, **13**, 7720-5 (2005)

6b <u>22 Papers published in non-peer-reviewed journals or conference proceedings</u>

1. Yaron Silberberg and George Stegeman, *Bright Spatial Solitons in Kerr Slab Waveguides*, book chapter in Spatial Solitons, S. Trillo and W. Torruellas editors (Springer-Verlag, Berlin, 2001) pp 37-60.

2. B. Luther-Davies and G.I. Stegeman, *Materials for Spatial Solitons*, book chapter in Spatial Solitons, S. Trillo and W. Torruellas editors (Springer-Verlag, Berlin, 2001) pp 19-35.

3. W. Torruellas, Y. Kivshar and G.I. Stegeman, *Quadratic Solitons*, book chapter in

Spatial Solitons, S. Trillo and W. Torruellas editors (Springer-Verlag, Berlin, 2001) pp 127-168.

4. G.I. Stegeman, *Experiments on Quadratic Solitons*, book chapter in Proceedings of NATO Advanced Research Workshop on “Soliton Driven Photonics”, A.D. Boardman and A.P. Sukhorukov editors, (Kluwer Academic Publishers, Holland, 2001), pp 21-3.

5. L. Friedrich, R. R. Malendevich, G.I. Stegeman**,** *Instability of Fast Kerr Solitons in AlGaAs Waveguides at 1.55 Microns*, book chapter in Proceedings of NATO Advanced Summer Institute on “Soliton Driven Photonics”, A.D. Boardman and A.P. Sukhorukov editors, (Kluwer Academic Publishers, Holland, 2001), pp 317-320.

6. R.R. Malendevich, H. Fang, R. Schiek, G.I. Stegeman, *Experiments on Seeded and Noise Initiated Modulational Instability in $LiNbO_3$ Slab Waveguides*, book chapter in Proceedings of NATO Advanced Summer Institute on “Soliton Driven Photonics, A.D. Boardman and A.P. Sukhorukov editors, (Kluwer Academic Publishers, Holland, 2001), pp 219-222.

7. T. Carmon, R. Uzdin, C. Pigier, Z. H. Musslimani, M. Segev and A. Nepomnyashchy, *Rotating Propeller Solitons*, Chapter in the book Proceedings of NATO Advanced Summer Institute on “Soliton Driven Photonics”, A.D. Boardman and A.P. Sukhorukov editors, (Kluwer Academic Publishers, Holland, 2001)

8. M. Segev and D. N. Christodoulides, *Incoherent Solitons: Self-Trapping of Weakly-Correlated Wave-Packets*, Chapter in the book Optical Spatial Solitons, Editors: S. Trillo amd W. Torruellas, Publisher: Springer-Verlag, Berlin, 2001.

9. J. B. Smathers, P. Ballet, Haeyeon Yang, C. L. Workman, V. R. Yazdanpanah and G.J. Salamo, *Nucleation Structure and Morphology Instabilities of InAs Self-Assembled Islands*, book chapter in Quantum Dots, A. D. Andreev editor, in the series Optoelectric Properties of Semiconductors and Superlattices, in press, 2002.

10. P. R. Prucnal, V. Baby,. D. Rand, B. C. Wang, and I. Glesk, “*All-optical Processing in Switching Networks*”, IEEE LEOS Newsletter **16** (4) 13-14 (2002).

11. G.I. Stegeman, “*All-Optical Switching*”, in the Handbook of Optics, edited by M. Bass, J. M. Enoch, E. W. VanStryland and W. L. Wolfe (McGraw Hill, New York, 2001) pp 21.1-21.9

12. V. Baby, L. Xu, B. C. Wang, I. Glesk, and P. R. Prucnal, “*Optical Spectral Bistability in a Widely Tuneable Fiber Ring Laser and its Applications for Bit-Lev el Optical Memory*,” Resent Research Development in Electronics, Vol. 1 - 2002, S. G. Pandalai, Editor, Transworld Research Network, Trivandrum, India, pp. 123-131.

13. I. Glesk, D. Rand, and P. R. Prucnal, “*TOAD: Ultrafast all-optical device for packet routing in future optical networks*,” Recent Research Development in Optics,

Vol. 3, Research Signpost, Trivandrum, India, 2003, pp. 89-102, ISBN:81-271-0028-5. Invited.

14. I. Glesk, B. C. Wang, L. Xu, V. Baby, and P. R. Prucnal, "*Ultra-fast all-optical switching in optical networks*," Progress in Optics Vol. 45, E. Wolf, editor, Elsevier Science, Netherlands, 2003, pp. 53–117. Invited.

15. T. Carmon, H. Buljan, M. Soljacic, and M. Segev, "*Pattern formation in optical cavities with incoherent light*", Optics and Photonics News, Special Issue: Optics in 2003, vol. 14(12), December (2003).

16. Ladislav Jankovic, Hongki Kim, George Stegeman, Silvia Carrasco, Lluis Torner and Mordechai Katz , "*Self-reflection and routing of multicolor solitons*," Optics & Photonics News (OPN) "Optics in 2003", 14(12):24, (2003)

17. George I. Stegeman, "Spatial Beam Instabilities Due to Instantaneous Nonlinear Mechanisms", book chapter in proceedings of NATO ASI/SUSSP56 titled *Ultrafast Photonics*, Ed. Alan Miller, D. T. Reid and D. M. Finlayson, (Institute of Physics Publishing, London, 2004) pp 103-21

18. G. Assanto and G. I . Stegeman, "*Nonlinear Optics Basics: Cascading*", in Encyclopedia of Modern Optics, edited by Robert D. Guenther, Duncan G. Steel and Leopold Bayvel, (Elsevier Press, 2004, Oxford), pp 207-12

19. E. Ultanir, G.I. Stegeman, D. Michaelis, C.H. Lange, and F. Lederer, "Dissipative Solitons in Semiconductor Optical Amplifiers", *Dissipative Solitons: Lecture Notes in Physics*, edited by Nail Akhmediev (Springer-Verlag, Heidelberg, 2005), **661**, pp37-54

20. N. K. Efremidis and D. N. Christodoulides, book chapter "*Discrete Ginzburg-Landau solitons", in "Dissipative Solitons*" edited by Akhmediev, Nail and Ankiewicz, Adrian, Springer-Verlag, 2005.

21. T. Coskun , M. Segev, and D. N. Christodoulides, book chapter, "*Incoherent Solitons*", in the Encyclopedia of Nonlinear Science, edited by A.C. Scott, Routledge, Dec. 2004.

22.. E. DelRe, M. Segev, D. Christodoulides, B. Crosignani, and G. Salamo, "*Photorefractive Solitons*" , book chapter in Photorefractive Materials and Their Applications 1, edited by P. Gunter, Springer 2005.

6c Papers presented at meetings, but not published in full conference proceedings

281 Conference papers, seminars etc presented relevant to MURI activities

Invited (94)

1. G. I. Stegeman, “Prospects for Higher Nonlinearities”, (invited) NSF Workshop on Networks for the 21st Century, Washington DC, December 2000

2. G.I. Stegeman, “Experiments with Quadratic Solitons”, (invited) 3 lectures at NATO ASI, Swinoujscie, Poland, September 2000

3. G. I. Stegeman, “Spatial Solitons: A New Frontier in Nonlinear Optics”, (invited) 1 hour tutorial, QELS2000, San Francisco, May 2000

4. I. Glesk, R. Runser, and P. R. Prucnal, "New Trends in Optical Communications", (invited) Proceedings of XIIth Czech- Slovak-Polish Optical Conference on Wave and Quantum Aspects of Contemporary Optics, p. 45, Velké Losiny, Czech Republic, September, 2000.

5. G. I. Stegeman, invited talk, Spatial Solitons and Nonlinear Beam Dynamics in Quadratically Nonlinear Media, colloquium at the University of Arkansas, Fayetteville, October 2001.

6. R. Schiek, invited talk, Modulational Instability of Plane-Wave Eigenmodes in Quadratic Nonlinear Media, Progress in Electromagnetics Research Symposium, Osaka Japan, July 2001.

7. G. I. Stegeman, invited talk, Modulational Instability: The Role of Dimensionality and Measurement of Instability Gain Coefficients in Quadratic Media, ICONO’2001, Minsk, Belaruss, June 2001.

8. G. I. Stegeman, invited talk, Spatial Modulational Instability in Planar Waveguides, NOMA 2001, Cetraro, Italy May 2001.

9. G. I. Stegeman, invited talk, Periodic Spatial Instabilities of High Intensity Beams in Waveguides, QELS 2001, Baltimore, May 2001.

10. G. I. Stegeman, seminar, Spatial Modulational Instability in Planar Waveguides, Dept. Physics, Frederich Schiller Universitat, Jena Germany, April 2001.

11. G. I. Stegeman, seminars, Spatial Solitons: An Experimental Overview, University of Queensland, Brisbane Australia; University of Melbourne, Melbourne Australia; University of New South Wales, Sydney Australia; Australian National University, Canberra, Australia, February 2001; University of Rome III, May 2001.

12. D. N. Christodoulides, Incoherent Spatial Solitons, invited talk, IMACS Conference on Nonlinear Evolution Equations and Wave Phenomena, Athens, Georgia, April 9-12, 2001.

13. D. N. Christodoulides, Incoherent Spatial Solitons, invited talk, paper QThK1, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

14. D. N. Christodoulides and M. Segev, Incoherent Spatial Solitons, invited talk, paper WN3, IEEE LEOS Annual Meeting, La Jolla California, November 11-15, 2001.

15. M. Segev, Incoherent Solitons: Self-Trapping of Weakly-Correlated Wave-Packets, Invited Talk, International Conference on Correlation Optics 99, Chernivtsy, Ukraine, May 2001.

16. M. Segev, M. Soljacic, D. Kip, Z. Chen, S. Sears, E. Eugenieva, and D. N. Christodoulides, Incoherent Modulation Instability: Pattern Formation in Weakly-Correlated Nonlinear Wave Systems, paper TuQ4, invited paper, OSA Annual Meeting, Long Beach, California, October 14-18, 2001.

18. M. Segev and D. N. Christodoulides, Incoherent Spatial Solitons, invited talk, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

19. M. Segev and D. N. Christodoulides, Incoherent Modulation Instability: Pattern Formation in Weakly-Correlated Nonlinear Wave Systems, Invited Talk, Optical Society of America Annul Meeting (OSA 01), Long Beach, California, October 2001.

20. M. Segev, Incoherent Solitons: Self-Trapping of Weakly-Correlated Wave-Packets, Invited Talk, International Conference on Correlation Optics 99, Chernivtsy, Ukraine, May 2001.

21. M. Segev, Progress on Optical Spatial Solitons , Invited Lecture, Optical Soliton Workshop 2001, Orlando, Florida, March 2001.

22. M. Segev, Progress on Optical Spatial Solitons , Invited Lecture, Optical Soliton Workshop 2001, Orlando, Florida, March 2001.

23. Lei Xu, Bing C Wang, Varghese Baby, Darren Rand, Ivan Glesk, and Paul R. Prucnal, "All-optical data format conversion between RZ and NRZ based on wavelength converter," Lasers and Electro-Optics Society, 2002. LEOS 2002. The 15th Annual Meeting of the IEEE, Volume: 1 , 2002, Page(s): 49 -50 paper MF2 (invited).

24. P. R. Prucnal, B. C. Wang, and I. Glesk, "Systems Perspective on Optical Processing/Packet Networks," paper TuG1, In 2002 Digest of the LEOS Summer Topical Meeting: All-optical networking Existing& Emerging Architecture & Applications, Chateau Mont Tremblant, QC Canada, pp. 15-16, 15-17 July, 2002. Invited paper

25. G. I. Stegeman, "Nonlinear Beam Dynamics in Media with Quadratic Nonlinearities", OSA Annual Meeting, Orlando, Sept. 2002

26. G. I. Stegeman "Optical Propagation in Quadratic Nonlinear Media: Plane Waves, Finite Beams and Solitons", Nonlinear Optics Applications, NOA' 2002, Miedzyzdroje Poland, Sept. 2002.

27. G. I. Stegeman, "Beam Dynamics in Nonlinear Media", 4 lectures, Scottish Universities Summer Schools in Physics, St. Andrews Scotland, Sept. 2002

28. G. I. Stegeman, "Overview of Spatial Soliton Experiments", Soliton Workshop, Varenna, Italy, Aug. 2002

29. G. I. Stegeman, "Spatial Soliton in Periodically Poled KTP (PPKTP)", Nonlinear Optics, Maui Hawai, July 2002

30. G. I. Stegeman, "Optical Propagation in Quadratic Nonlinear Media: Plane Waves, Finite Beams and Solitons", plenary, Laser Physics Workshop (LPHYS'02), Bratislava (Slovak Republic), July 2002

31. M. Segev, D. N. Christodoulides, M. Soljacic, Z. Chen, D. Kip, and S. Sears, "Pattern formation and clustering of solitons in nonlinear weakly-correlated wave-systems", invited talk QThL3, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

32. M. Segev, D. N. Christodoulides, M. Soljacic, Z. Chen, D. Kip, S. Sears, and T. Carmon, "Pattern formation and clustering of solitons in nonlinear weakly-correlated wave-systems", invited talk ThD3, NLO 02, Maui, Hawaii, July 29-August 2, 2002.

33. G.I. Stegeman, invited talk, Nonlinear Beam Dynamics in Media with Quadratic Nonlinearities, OSA Annual Meeting, Orlando, Sept. 2002.

34. G.I. Stegeman, invited talk, 1D QPM Solitons in Homogeneous and Discrete $LiNbO_3$ Waveguides, Nonlinear Optics Applications, NOA' 2002, Miedzyzdroje Poland, Sept. 2002.

35. G.I. Stegeman, invited talk, Beam Dynamics in Nonlinear Media, Scottish Universities Summer Schools in Physics, St. Andrews Scotland, Sept. 2002.

36. G. I. Stegeman, invited talk, Spatial Soliton in Periodically Poled KTP (PPKTP), Nonlinear Optics, Maui Hawai, July 2002.

37. G. I. Stegeman, invited talk, Spatial Solitons, Laser Physics Workshop (LPHYS'02), Bratislava (Slovak Republic), July 2002.

38. G. I. Stegeman, "Real Optical Beam Instability and Coherent Spatial Soliton Experiments With Non-Ideal Samples and Non Ideal Sources", UCLA Workshop on Emerging Applications of the Nonlinear Schrödinger Equations, Los Angeles, Feb. 2003

39. Joachim Meier, G. I. Stegeman, S. Aitchison, R. Morendotti, and Y. Silberberg, "Nonlinear Interactions in Discrete Systems", (invited paper) Annual LEOS Meeting, Tucson, Arizona, October 2003, paper MC2

40. S. Carrasco, D. V. Petrov, J. P. Torres, L. Torner, H. Kim and G. I. Stegeman, "Tandem Multicolor Solitons", (invited paper) Annual LEOS Meeting, Tucson, Arizona, October 2003, paper WC1

41. S. Aitchison, R. Morandotti, D. Mandelik, H. S. Eisenberg, Y. Silberberg, J. Meier, and G. I. Stegeman, "Discrete Spatial Solitons in Kerr Media", (invited paper), Frontiers in Optics (Annual OSA), Tucson Arizona, October 2003, paper MZ2

42. W. Sohler, W. Grundkutter, J. H. Lee, Y. L. Lee, Y. H. Min, V. Quiring, R. Ricken, H. Suche, R. Schiek, T. Pertsch, F. Lederer. R. Iwanow and G. I . Stegeman , "All-optical wavelength conversion, amplification and switching in periodically poled Ti:LiNbO3 waveguide structures", (invited paper), Annual LEOS Meeting, Tucson Arizona, October 2003, paper TuS1

43. E. Ultanir, G. I. Stegeman, Chr. Lange and F. Lederer, "Dissipative Propagating Spatial Solitons (Autosolitons) in Semiconductor Amplifiers", (invited paper) Topical Problems of Nonlinear Wave Physics (NWP-2003), Nizhny Novgorod Russia, September 2003

44. L. Jankovic. H. Kim, S. Polyakov, G. I. Stegeman, S. Carrasco, L. Torner, Chr. Bosshard, P. Gunter, M. Katz and David Eger, "Interactions of Quadratic Spatial Solitons in Non-Critical-Phase-Matching Geometries", (invited paper), Laser Physics Workshop (LPHYS'03), Hamburg Germany, August 2003

45. G. I. Stegeman, E. Ultanir, Chr. Lange and F. Lederer, "Dissipative Solitons in Semiconductor Optical Amplifiers", (invited paper) Banfi Memorial Workshop, Pavia Italy, June 2003

46. George I. Stegeman, Ladislav Jankovic, Hongki Kim, Sergey Polyakov, S. Carrasco, L. Torner, Chr. Bosshard, P. Gunter, M. Katz and David Eger, "Spatial Solitons in Non-Critically-Phase-Matched Crystals", (invited paper) NOMA'2003, Cetraro, Italy June 2003

47. Joachim Meier, George Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "Discrete Beam Interaction in Waveguide Arrays", (invited paper), IMACS'2003, Athens Georgia, April 2003

48. J. W. Fleischer, M. Segev, N. K. Efremidis, and D. N. Christodoulides, "Observation of two-dimensional discrete solitons in optically-induced nonlinear photonic lattices", invited paper, paper QThK1, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

49. D. N. Christodoulides, N. Efremidis, J. Fleischer, and M. Segev, "Discrete solitons", invited talk, NOMA, Cetraro, Italy, June 8-13 (2003).

50. N. K. Efremidis, J. Hudock, D. N. Christodoulides, J. W. Fleischer, and M. Segev, "Nonlinear waves in periodic lattices", invited talk, IMACS, Athens, Georgia, April 7-10, 2003.

51. M. Segev, J. W. Fleischer, D. N. Christodoulides, N. K. Efremidis, and T. Carmon, "Discrete solitons in optically-induced lattices" invited talk, European Conference on Lasers and Electro-optics, Munich, Germany, June 22-27, 2003.

52. J. W. Fleischer, M. Segev, N. K. Efremidis, and D. N. Christodoulides, "Discrete solitons in optically-induced photonic lattices", invited talk, paper MZ3, OSA Annual Meeting, Tucson, Arizona, October 5-9, 2003.

53. J. W. Fleischer, O. Cohen, G. Bartal, T. Schwartz, H. Buljan, O. Manela, M. Segev, N.K. Efremidis, J. Hudock, and D. N. Christodoulides, "Solitons in 2D optically-induced photonic lattices", invited talk, paper MC1, IEEE/LEOS 2003, Tucson, Arizona, October 26-30, 2003.

54. G J. Salamo, "Engineering quantum structures and their behavior" MRS, Fall Meeting 2003(Invited)

55. I. Glesk, L. Xu, V. Baby, P. Patel, D. Rand, and P. R. Prucnal, "An Optical Platform for Ultra-fast Signal Processing and Networks" Europe- U.S. -Japan Symposium on Ultrafast Photonic Technology, Makuhari Messe, Chiba, Japan, July 15, 2003 (invited paper).

56. G. Bartal, O. Cohen, H. Buljan, J.W. Fleischer, O. Manela, and M. Segev, "Fourier-space imaging in nonlinear photonic lattices", invited talk, Frontiers in Optics, Rochester, New York, October 2004.

57. G. I. Stegeman, E. Ultanir, Chr. Lange and F. Lederer, "Dissipative Solitons in SOAs and Their Interactions", (invited paper) Photonics and Imaging Initiatives Workshop, Tucson Arizona, January 21-23 (2004)

58. G. I. Stegeman, R. Schiek, D. Christodoulides, J. Meier, R. Iwanow, S. Aitchison, R. Morandotti, Y. Silberberg, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "Discrete Solitons, Their Instabilities and Interactions in Quadratic and Cubically Nonlinear Media", (invited paper) Winter School in Nonlinear and Stochastic Optics, Tucson Arizona, January 10-13 (2004)

59. G.I. Stegeman, J. Meier, S. Aitchison, R. Morendotti, Y. Silberberg and G. Salamo, "Spatial Solitons", (colloquium) Dept. of Physics, University of Toronto, April (2004)

60. T. Pertsch, G. I. Stegeman, R. Schiek, R. Iwanow, F. Lederer, Y. Min and W. Sohler "Transparent Switching in PPLN Waveguide Arrays", (invited paper), CLEO'2004, San Francisco, May 2004

61. G.I. Stegeman, J. Meier, S. Aitchison, R. Morendotti, Y. Silberberg and G. Salamo, "Spatial Solitons and Instabilities in Discrete Kerr Media", (invited paper) NOA' 2004, Warsaw Poland, June 2004.

62. Robert Iwanow, T. Pertsch, G. I. Stegeman, R. Schiek, F. Lederer, Y. Min and W. Sohler "Discrete Quadratic Solitons in PPLN Arrays", (invited paper), NOA' 2004, Warsaw Poland, June 2004.

63. G. I. Stegeman, E. Ultanir, Chr. Lange and F. Lederer, "Dissipative Solitons in Semiconductor Optical Amplifiers and Their Interactions", (invited paper) ICTON 2004, Wroclaw Poland, July 2004

64. G.I. Stegeman, J. Meier, S. Aitchison, R. Morendotti, Y. Silberberg and G. Salamo, "Spatial Solitons in Discrete Nonlinear Media", (invited paper) Laser Physics Workshop (LPHYS'04), Trieste, Italy, July 2004

65. G.I. Stegeman, J. Meier, S. Aitchison, R. Morendotti, Y. Silberberg, G. Salamo, R. Iwanow, T. Pertsch, R. Schiek, F. Lederer, Y. Min and W. Sohler "Experiments in Spatial Solitons", (invited paper) Workshop at International Centre for Mathematical Sciences (ICMS), Edinburgh Scotland, July 2004

66. D. N. Christodoulides, "Discrete solitons", invited talk, NLGW workshop, Toronto, Canada, March 27, 2004.

67. M. Segev, J. W. Fleischer, O. Cohen, H. Buljan, G. Bartal, T. Schwartz, O. Manela, N. K. Efremidis, J. Hudock, and D. N. Christodoulides, "Wave propagation and solitons in 2D photonic lattices", invited talk, CLEO/IQEC 2004, San Francisco, California, May 16-21, 2004, paper JTuD3.

68. D. N. Christodoulides, "Discrete solitons", invited talk, ICMS Workshop on Mathematical Issues in Nonlinear Optics, Edinburgh, UK, July 18-24, 2004.

69. D. N. Christodoulides, "Discrete optical solitons", invited talk, Nonlinear Optics, Waikoloa-Hawaii, August 2-6, 2004.

70. D. N. Christodoulides, "Two-dimensional discrete solitons in optically induced nonlinear photonic lattices", invited talk, CLEO/IQEC 2004, San Francisco, California, May 16-21, 2004.

71. G. I. Stegeman, E. Ultanir, Chr. Lange and F. Lederer, "Dissipative Solitons in SOAs and Their Interactions", (invited paper) Photonics and Imaging Initiatives Workshop, Tucson Arizona, January 21-23 (2004)

72. G. I. Stegeman, Roland Schiek, Demetri Christodoulides, Joachim Meier, Robert Iwanow, Stewart Aitchison, Roberto Morendotti, Yaron Silberberg, Thomas Pertsch, Falk Lederer, Yoohong Min and Wolfgang Sohler, "Discrete Solitons, Their Instabilities and Interactions in Quadratic and Cubically Nonlinear Media", (invited paper) Winter School in Nonlinear and Stochastic Optics, Tucson Arizona, January 10-13 (2004)

73. G. I. Stegeman, E. A. Ultanir, D. Christoulides, C. H. Lange and F. Lederer, "Dissipative Solitons in SOAs and Their Interactions", (invited), LEOS Annual Meeting, Puerto Rico, November (2004)

74. G. I. Stegeman, "What are Optical Solitons and Why Are They Interesting", School on Optics and Photonics (1 hr student tutorial) RIAO/OPTILAS 2004, Porlamar Venezuela, October 2004

75. G. I. Stegeman, J. Meier, S. Aitchison, Y. Silberberg, R. Morandotti, H. Yang, and G. Salamo, "Discrete Spatial Solitons in 1D, Kerr, Optical Arrays", (invited) RIAO/OPTILAS 2004, Porlamar Venezuela, October 2004

76. R. Iwanow, R. Schiek, G. I. Stegeman, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "Discrete Quadratic Solitons in 1D Arrays", (invited), SIAM Meeting on Nonlinear Waves and Coherent Structures, Orlando, October (2004)

77. W. Sohler, W. Grundkötter, J. H. Lee, Y. H. Min, V. Quiring, H. Suche, R. Schiek, T. Pertsch, F. Lederer, R. Iwanow, and G. I. Stegeman, "All-Optical Signal Processing in Periodically Poled LiNbO3 Waveguide Structures" (invited, given by Wolfgang Sohler), ECOC`04, Stockholm Sweden, September (2004)

78. D. N. Christodoulides, "Discrete and lattice optical solitons" invited paper, SIAM meeting, Orlando, Florida, October 2-5, 2004.

79. G. I. Stegeman, "Dawn of Discreteness in Optics", Stoicheff 70'th Birthday Celebration (invited), Toronto, December 2005

80. G. I. Stegeman, "Discrete Linear and Nonlinear Optics", Colloquium Lehigh University, October 2005

81. George I. Stegeman, Joachim Meier, Demetri Christodoulides, Roberto Morondotti, H. Yang, G. Salamo and M. Sorel, "Discrete "Blocker" Solitons for Routing in AlGaAs Arrays", Frontiers in Optics (invited), Tucson, October 2005

82. G. I. Stegeman, E. Ultanir, D. Christodoulides, F. Lederer, and C. H. Lange, "Dissipative Spatial Solitons in Semiconductor Optical Amplifiers", (invited paper) NLGW'2005, Dresden Germany, September 2005

83. G. I. Stegeman, "Linear and Nonlinear Discrete Optics", (plenary talk), SPIE International Congress on Optics and Optoelectronics, Warsaw Poland, August 2005

84. G. I. Stegeman, “Nonlinear Beam Propagation in Quadratically Nonlinear Materials”, (tutorial) CLEO 2005, Baltimore, May (2005)

85. G. I. Stegeman, “Discrete Spatial Solitons”, (tutorial), ICONO 2005, St. Petersburg Russia, May 2005

86. G. I. Stegeman, E. A. Ultanir, D. Christoulides, C. H. Lange and F. Lederer, “Dissipative" Spatial Solitons and Their Interactions in SOAs”, (invited) ECIO 2005, Grenoble France, April 2005

87. D. N. Christodoulides, “All-optical routing using discrete solitons”, invited paper, paper 5735-07, Photonics West, San Hose, California, January 22-27, 2005.

88. D. N. Christodoulides, “Discrete solitons in waveguide arrays and optical lattices”, Keynote Speech, The fourth IMACS international conference on Nonlinear Evolution Equations and Wave Phenomena, Athens, Georgia, April 11-14, 2005.

89. D. N. Christodoulides, “Discrete solitons in waveguide arrays and optical lattices”, invited talk, ISE1, ICONO/LAT 2005, St. Petersburg, Russia, May 11-15, 2005.

90. B. Freedman, G. Bartal, M. Segev, D. Christodoulides, J. Fleischer, “Optical quasi-crystals-properties and dynamics”, invited talk, paper QThK1, CLEO/QELS, Baltimore, Maryland, May 22-27, 2005.

91. M. Segev, “Solitons in photonic lattices”, plenary talk, Conference on Nonlinear Waves, Integrable Systems, and their Applications, Boulder, Colorado, June 2005.

92. M. Segev, “Solitons and nonlinear waves in photonic lattices”, plenary talk of the Division of Quantum Optics, Annual Meeting of the German Physical Society (DPG), Berlin, Germany, March 2005.

93. M. Segev, “Solitons and nonlinear waves in photonic lattices”, invited talk, French-Israeli Symposium on Nonlinear and quantum Optics (FRISNO 2005), Ein Bokek, Israel,, February 2005.

94. M. Soljacic E. Lidorikis, J.D. Joannopoulos, L.V. Hau, M. Segev, K. Steiglitz, and C. Anastassiou, “New windows of opportunity for all-optical information processing: spatial solitons, EIT in micro-cavities, etc.”, invited talk, SPIE Conference on Optoelectronics 2005, San Jose, California, January 2005.

<u>Contributed (187)</u>

1. P. V. Studenkov, M. R. Gokhale, J. Wei, W. C. Lin, I. Glesk, P. R. Prucnal, and S. R. Forrest, "Integrated, Asymmetric twin-waveguide ultrafast all-optical switch," IEEE LEOS'00, paper WCC4, pp. 645-646, Rio Grande, Puerto Rico, November 2000.

2. R. J. Runser, C. Coldwell, P. Toliver, I. Glesk, and P. R. Prucnal, "A Practical All-Optical Sampling Technique for High Bandwidth, Low Energy Optical Communication Signals," IEEE LEOS'00, paper THJ3, pp. 770-771, Rio Grande, Puerto Rico, November 2000.

3. B. Wang, I. Glesk, Robert J. Runser and P. R. Prucnal, "Tunable Parallel Optical Delay Line," IEEE LEOS'00, paper WZ3, pp. 621-622, Rio Grande, Puerto Rico, November 2000.

4. D. Zhou, B. Wang, I. Glesk and P. R. Prucnal, "Perfectly Synchronized Bit-Parallel WDM Data Transmission Over a Single Optical Fiber," The 2000 IEEE/LEOS Summer Topical Meetings, Aventura, Florida, July 2000.

5. R. J. Runser, I. Glesk, and P. R. Prucnal, "Experimental Demonstration of a 1.5 ps Demultiplexing Window for High Speed Optical Networks Using a Forward-Pumped Mach Zehnder TOAD", CISS2000, Proceedings of 34th Annual Conference on Information Sciences and Systems, Princeton University, NJ, March , 2000

6. D. Zhou, I. Glesk and P. R. Prucnal, "A novel optical pulse width management device," in CLEO Technical Digest (Opt. Soc. Am., Washington DC, 2000), pp. 133.

7. P. Toliver, R. J. Runser, I. Glesk, and P. R. Prucnal, "Comparison of Three Nonlinear Optical Switch Geometries," in CLEO Technical Digest (OSA, Washington DC, 2000), pp. 254-255.

8. H. Fang, R. Malendevich, R. Schiek and G. I. Stegeman, "Spatial Modulational Instability in One-Dimensional $LiNbO_3$ Slab Waveguides", QELS 2000 Digest, San Francisco CA, May 2000, paper QThP2

9. L. Friedrich, R.R. Malendevich, G.I. Stegeman, J.M. Soto-Crespo, N.N. Akhmediev and J.S. Aitchison, "Are spatial solitons of both polarizations stable in Kerr slab waveguides?", QELS 2000 Digest, San Francisco CA, May 2000, paper QThP5

10. R. Schiek, C.G. Trevino-Palacios, J. Meier, H. Fang, L. Friedrich, G.I. Stegeman, K.R. Parameswaran, M.-H. Chou and M.M. Fejer, "High-power second-harmonic generation experiments in periodicially poled lithium niobate waveguides" CLEO 2000 Digest, San Francisco CA, May 2000, CWH2

11. H. Fang, R. Malendevich, G.I. Stegeman and R. Schiek, "Characterization of spatial modulational instability of second-order nonlinear eigenmodes in a slab waveguide", Topical Meeting on "Nonlinear Optics: Materials, Fundamentals and Applications", Kaua'i-Lihue Hawaii, August 2000, TuB11

12. R.R. Malendevich, H. Fang, R. Schiek, G.I. Stegeman "Experiments on Seeded and Noise Initiated Modulational Instability in $LINBO_3$ Slab Waveguides", NATO ASI on Soliton Driven Photonics", Swinoujscie, Poland, September 2000

13. R.R. Malendevich, L. Friedrich, R.R. Malendevich, G.I. Stegeman, J.M. Soto-Crespo, N.N. Akhmediev and J.S. Aitchison, "Instability of Fast Kerr Solitons in AlGaAs Waveguides at 1.55 Microns", NATO ASI on Soliton Driven Photonics", Swinoujscie, Poland, September 2000

14. Yan-qing Lu, Min Xiao and Gregory J. Salamo, *Wide-Bandwidth High-Frequency Electro-optic Modulator Based on Periodically Poled* $LiNbO_3$, CLEO 2001.

15. Xiaodong Mu, Yujie J. Ding, Haeyeon Yang, and Gregory J. Salamo, *Cavity-Enhanced and Quasi-Phase-Matched Multi-Order Reflection-Second-Harmonic Generation From GaAs/AlAs and GaAs/AlGaAs Multilayers,* CLEO 2001.

16. R. Uzdin, M. Segev, G. Salamo, *Self-Focusing in InP*, CLEO 2001

17. P. Ballet, H. Yang, C. L. Workman and G.J. Salamo, *GaAs Dots on GaP,* MRS, 2001.

18. Haeyeon Yang, P. Ballet, and G.J. Salamo, *Formation of Quantum Wires and Dots on InP(001) by As/P Exchange*, MRS**,** 2001 .

19. Bing C. Wang, Varghese Baby, Lei Xu, Ivan Glesk, Paul R. Prucnal, *A Fast Optical Switch Based on Two Cascaded Terahertz Optical Asymmetric Demultiplexers (TOAD)*, In Proceedings of CISS Conference, Princeton, NJ, USA. In press.

20. L. Xu, B. C. Wang, V. Baby, I. Glesk, and P. R. Prucnal, *Performance-Improved All Optical RZ to NRZ Format Conversion for Hybrid Optical Networking Interface*, In Proceedings of CISS Conference, Princeton, NJ, USA. In press.

21. B. Wang, L. Xu, V. Baby, I. Glesk, and P. Prucnal, *Wavelength-Tunable Optical Spectral Bistability in a Ring Laser Using a Semiconductor Optical Amplifier,* IEEE LEOS'01, paper ThL1, pp. 748-749, Vol 2, Hyatt Regency, La Jolla, San Diego, CA, 12 13 November 2001.

22. L. Xu, B. C. Wang, V. Baby, I. Glesk, P. R. Prucnal, M. Yao, and J. Zhang, *All-Optical Clock-Division Operation Using a Mode-Locked Fiber Laser Based on the Slow Carrier Recovery Rate of SOA*, IEEE LEOS'01, paper MK4, pp. 87-88, Vol 1, Hyatt Regency, La Jolla, San Diego, CA, 12-13 November 2001.

23. L. Xu, B. C. Wang, V. Baby, I. Glesk, and P. R Prucnal, *Widely Tunable Fiber Ring Laser with EDFA/SOA*, IEEE LEOS'01, paper WC4, pp. 421-422, Vol 2, Hyatt Regency, La Jolla, San Diego, CA, 12-13 November 2001.

24. I. Glesk, B. C. Wang, L. Xu, D. Zhou, R. J. Runser, P. R. Prucnal, *Bit Pattern Dependent Effect Reduction in All-Optical 3R Regeneration* in Conference Proceedings 3rd Electronic Circuits and Systems Conference, Bratislava, Slovakia, September 5-7, 2001.

25. B. C. Wang, L. Xu, D. Zhou, R. J. Runser, I. Glesk, and P. R. Prucnal, *Pattern Dependent Effect Reduction in 3R Regeneration Using a Three Wavelength Sagnac Interferometer in Photonics in Switching*, OSA Technical Digest (Optical Society of America, Washington DC, 2001, pp. 49/PThC5-1 – 51/PThC5-3.

26. S. Sears, Z. Chen, H. Martin, D. N. Christodoulides, and M. Segev, *Clustering in Weakly Correlated Wavefronts*, paper TuQ6, OSA Annual Meeting, Long Beach, California, October 14-18, 2001.

27. M. I. Carvalho, A. G. Grandpierre, D. N. Christodoulides, and M. Segev, *Optical Spatial Shock Waves in Photorefractive Media*, paper QThO7, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

28. E. D. Eugenieva, D. N. Christodoulides, and M. Segev, *Dynamics of Two-Dimensional Incoherent Beams Resting on a Broad Intensity Background*, paper CThK1, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

29. E. D. Eugenieva and D. N. Christodoulides, *Self-Deflection of Partially Spatially Coherent Beams and Solitons in Photorefractive Crystals*, paper CThK3, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

30. Z. H. Musslimani, M. Soljacic, M. Segev, and D. N. Christodoulides, *Delayed-Action Interaction Between Two-Dimensional Composite Solitons*, paper QthO4, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

31. C. Anastassiou, M. Soljacic, M. Segev, E. D. Eugenieva, D. N. Christodoulides, D. Kip, Z. H. Musslimani, and J. P. Torres, *Eliminating the Transverse Instabilities of Kerr Solitons*, paper QThK5, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

32. D. Kip, M. Soljacic, M. Segev, E. D. Eugenieva, and D. N. Christodoulides, *Modulation Instability and Pattern Formation of Incoherent Light*, paper QWD2, CLEO/QELS 2001, Baltimore, Maryland, May 6-11, 2001.

33. R. R. Malendevich, *Fission of Narrow High Power Beams into Multiple Solitons in a Second-Order Nonlinear Slab Waveguide*, QELS 2001 Technical Digest, Baltimore, QThK6.

34. L. Jankovich, *Observation of Satial Modulation Instability in a Slab Waveguide with Third Order Nonlinearity*, OSA Annual 2001, Long Beach, October 2001, TuD3.

35. R. Schiek, H. Fang, and G. I. Stegeman, *Excitation of Quadratic Solitons*, Topical Meeting on Nonlinear Guided Wave Phenomena, Clearwater Florida, March 2001, postdeadline paper.

36, A. G. Grandpierre, D. N. Christodoulides, M. I. Carvalho, and M. Segev, *Optical Spatial Shock Waves in Photorefractive Media*, paper MC26, Nonlinear Guided Waves and their Applications 2001, Clearwater, Florida, March 25-28, 2001.

37. E. D. Eugenieva, D. N. Christodoulides, and M. Segev, *Dynamics of Two-Dimensional Incoherent Beams Resting on a Broad* Intensity *Background*, paper MC28, Nonlinear Guided Waves and their Applications 2001, Clearwater, Florida, March 25-28, 2001.

38. E. D. Eugenieva and D. N. Christodoulides, *Self-Deflection of Partially Spatially Coherent Beams and Solitons in Photorefractive Crystals*, paper MC29, Nonlinear Guided Waves and their Applications 2001, Clearwater, Florida, March 25-28, 2001.

39. D. Kip, M. Soljacic, M. Segev, E. D. Eugenieva, and D. N. Christodoulides, *Modulation Instability and Pattern Formation of Incoherent Light*, paper MA5, Nonlinear Guided Waves and their Applications 01, Clearwater, Florida, March 25-28, 2001.

40. C. Pigier, C. Anastassiou, M. Segev, D. Kip, E. D. Eugenieva, and D. N. Christodoulides, *Self-Trapping of Bright Rings*, paper WC7, Nonlinear Guided Waves and their Applications 01, Clearwater, Florida, March 25-28, 2001.

41. C. Anastassiou, M. Soljacic, M. Segev, E. D. Eugenieva, D. N. Christodoulides, D. Kip, Z. H. Musslimani, and J. P. Torres, *Eliminating the Transverse Instabilities of Kerr Solitons*, Nonlinear Guided Waves and their Applications 2001, paper TuB4, Clearwater, Florida, March 25-28, 2001.

42. Z. H. Musslimani, M. Soljacic, M. Segev, and D. N. Christodoulides, *Collisions Between (2+1)D Composite Solitons: Delayed-Action Interaction and Spin-Orbit Coupling*, paper MC44, Nonlinear Guided Waves and their Applications 2001, Clearwater, Florida, March 25-28, 2001.

43. S. Sears, Z. Chen, H. Martin, D. N. Christodoulides, and M. Segev, *Clustering in Weakly Correlated Wavefronts*, post-deadline paper PD3, Nonlinear Guided Waves and their Applications 2001, Clearwater, Florida, March 25-28, 2001.

44. N. K. Efremidis, D. N. Christodoulides, S. Sears, and M. Segev, *Discrete Solitons in Photorefractive Optically-Induced Photonic Crystals*, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

45. J. W. Fleischer, T. Carmon, M. Segev, N. K. Efremidis, and D. N. Christodoulides, *Discrete Diffraction in Optically-Induced Real-Time Waveguides in Photorefractives*, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

46. J. Klinger, Z. Chen, and D. N. Christodoulides, *Propagation of a Spatially-Modulated Incoherent Beam in a Photorefractive Medium*, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

47. A. G. Grandpierre, N. Efremidis, J. Hudock, and D. N. Christodoulides, *Discrete Solitons in Time-Domain Photonic Crystals*, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

48. E. Eugenieva and D. N. Christodoulides, *Minimizing Bending Losses in Two-Dimensional Discrete Soliton Networks*, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

49. E. Eugenieva and D. N. Christodoulides, *Blocking and Routing Discrete Solitons in Two-Dimensional Networks of Nonlinear Waveguide Aarrays*, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

50. J. W. Fleischer, T. Carmon, M. Segev, N. K. Efremidis, and D. N. Christodoulides, "*Discrete solitons in optically-induced photonic lattices*", post-deadline paper PD-10, NLO 02, Maui, Hawaii, July 29-August 2, 2002.

51. N. K. Efremidis, J. Hudock, and D. N. Christodoulides, "*Discrete solitons in nonlinear zig-zag optical waveguide arrays with tailored diffraction prop*erties", paper NLMD35, NLGW 2002, Stresa, Italy, Sept.1-3, 2002.

52. N. K. Efremidis, J. Hudock, D. N. Christodoulides, J. Fleischer, and M. Segev, "*Discrete solitons in photorefractive optically-induced photonic lattices*", paper NLTuA4, NLGW 2002, Stresa, Italy, Sept.1-3, 2002.

53. J. Fleischer, M. Segev, T. Carmon, N. K. Efremidis, and D. N. Christodoulides, "*Discrete solitons in optically-induced real-time waveguide arrays*", paper NLTuA8, NLGW 2002, Stresa, Italy, Sept.1-3, 2002.

54. N. K. Efremidis, J. Hudock, D. N. Christodoulides, and E. Eugenieva,, "*Blocking and routing discrete solitons in two-dimensional networks of nonlinear waveguide arrays*", paper NLTuD35, NLGW 2002, Stresa, Italy, Sept.1-3, 2002.

55. J. Hudock, N. K. Efremidis, D. N. Christodoulides, and E. Eugenieva,, "*Minimizing bending losses in two-dimensional discrete soliton networks*", paper NLTuD36, NLGW 2002, Stresa, Italy, Sept.1-3, 2002.

56. D. N. Christodoulides and N. Efremidis, "*Discrete temporal solitons along a chain of nonlinear coupled microcavities embedded in photonic crystals*", paper NLWC2, NLGW 2002, Stresa, Italy, Sept.1-3, 2002.

57. N. K. Efremidis, J. Hudock, and D. N. Christodoulides, "*Discrete solitons in nonlinear zig-zag optical waveguide arrays with tailored diffraction properties*", paper ThBB1, OSA Annual Meeting 2002, Orlando, Florida, Sept. 29- Oct. 3, 2002.

58. N. K. Efremidis, J. Hudock, and D. N. Christodoulides, "*Discrete temporal solitons along a chain of nonlinear coupled microcavities embedded in photonic crystals*", paper ThBB2, OSA Annual Meeting 2002, Orlando, Florida, Sept. 29- Oct. 3, 2002.

59. J. Hudock, N. K. Efremidis, and D. N. Christodoulides, "*Diffraction management and elliptic discrete solitons in two-dimensional waveguide array lattices*", paper ThBB5, OSA Annual Meeting 2002, Orlando, Florida, Sept. 29- Oct. 3, 2002.

60. N. K. Efremidis, J. Hudock, D. N. Christodoulides, J. Fleischer, S. Sears, and M. Segev, "*Discrete solitons in photorefractive optically-induced photonic lattices*", paper ThBB6 paper ThBB5, OSA Annual Meeting 2002, Orlando, Florida, Sept. 29- Oct. 3, 2002.

61. L. Workman, Z. M. Wang, W. Q. Ma, C. E. George, R. P. Selvam, G. J. Salamo, R. Barbera, Q. Zhou, and M. O. Manasreh, "*Intersubband Transitions in InxGa1xAs/AlGaAs Multiple Quantum Wells for Long Wavelength Infrared Detection",* Proceeding of MRS Fall, Dec. 2002.

62. H. Wen, Z. M. Wang, and G. J. Salamo, "*Two-dimensional epitaxial growth of strained InGaAs on GaAs (100)"*, Proceeding of MRS Fall, Dec. 2002.

63. X. Mu, Y. J. Ding, I. B. Zotova, H. Yang, and G. J. Salamo, *"Growth and characterization of single and stacked InP/InAs/InP quantum wires*, *Quantum Dot Sources and Detectors"*, James A. Lott, Nikolai N. Ledentsov, and Kevin J. Malloy, Editors, Proceedings of SPIE Vol. 4656, June 2002.

64. X. Mu, Y. J. Ding, H. Yang, and G. J. Salamo, "*Vertically stacking 10 periods of self-assembled InAs/InP quantum wires"*, May, CLEO'02.

65. A. Guo, M. Henry, G. Salamo, M Segev, and G. Wood, "*Fixing Multiple Waveguides Induced by Photorefractive Solitons: Optical Modulators"*, May, CLEO'02.

66. A. Tang, A. Guo, and G. Salamo, "*Matrix Algebra Using Optical Solitons"*, May, CLEO'02

67. X. Mu, I. B. Zotova, Y. J. Ding, H. Yang, and G. J. Salamo, "*Growth and characterization of single and stacked InP/InAs/InP quantum wires"*, Quantum Dot Sources and Detectors," Optoelectronics, Photonics West'02, San Jose, CA, Jan., 2002.

68. N. K. Efremidis, D. N. Christodoulides, S. Sears, and M. Segev, "*Discrete solitons in photorefractive optically-induced photonic crystals*", paper QWA14, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

69. J. W. Fleischer, T. Carmon, M. Segev, N. K. Efremidis, and D. N. Christodoulides, "*Discrete diffraction in optically-induced real-time waveguides in photorefractives*", paper QThI5, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

70. J. Klinger, Z. Chen, and D. N. Christodoulides, "*Propagation of a spatially-modulated incoherent beam in a photorefractive medium*", paper CTuL6, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

71. A. G. Grandpierre, N. Efremidis, J. Hudock, and D. N. Christodoulides, "*Discrete solitons in time-domain photonic crystals*", paper QWE2, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

72. E. Eugenieva and D. N. Christodoulides, "*Minimizing bending losses in two-dimensional discrete soliton networks*", paper QWA13, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

73. E. Eugenieva and D. N. Christodoulides, "*Blocking and routing discrete solitons in two-dimensional networks of nonlinear waveguide arrays*", paper QWE1, CLEO/QELS 2002, Long Beach, California, May 19-24, 2002.

74. Ladislav Jankovic, Roman Malendevich, Sergey Polyakov, Russell Fuerst , George Stegeman, Christian Bosshard and Peter Gunter , "*Symmetry Properties of Two-Dimensional Quadratic Spatial Solitons For Non-Critical Phase-Matching in* $KNbO_3$", QELS'2002, Long Beach, May 19-24, 2002, paper QThI1

75. Robert Iwanow, Roland Schiek, George Stegeman, Thomas Pertsch, Falk Lederer, Yoo Hong Min and Wolfgang Sohler, "*Diffractionless Propagation in Low Loss* $LiNbO_3$ *Channel Waveguide Arrays*", CLEO'2002, Long Beach, May 19-24, 2002, paper CTuK13

76. Sergey Polyakov, Roman Malendevich, Ladislav Jankovic, George Stegeman, Christian Bosshard and Peter Gunter, "*Multi spatial soliton excitation by a single beam in non-critically phase-matched biaxial crystals*", QELS'2002, Long Beach, May 19-24, 2002, paper QWA28

77. Hongki Kim, Ladislav Jankovic, Roman Malendevich, George Stegeman, Mordechai Katz, Silvia Carrasco and Lluis Torner, "*Quadratic Spatial Solitons in Bulk Periodically Poled KTP*", CLEO'2002, Long Beach, May 19-24, 2002, paper CWL2

78. E. Ultanir, G.I. Stegeman, D. Michaelis, and F. Lederer, "*Stable spatial solitons in semiconductor optical amplifiers*", CLEO'2002, Long Beach, May 19-24, 2002, paper CTu4

79. G. Stegeman, R. Malendevich, R. Schiek, R. Iwanow, L. Jankovic, H. Fang, Gerhard Schreiber, Wolfgang Sohler and Lluis Torner, "*Nonlinear Beam Dynamics in* $\chi^{(2)}$ *Waveguides*", IQEC'2002, Moscow Russia, June 22-28 2002, paper QSuF1

80. George Stegeman, Roman Malendevich, Ladislav Jankovic, Christian Bosshard and Peter Gunter, "*Quadratic Solitons in Non-Critically Phase-Matched Crystals*", IQEC'2002, Moscow Russia, June 22-28 2002, paper QSuF6

81. Sergey Polyakov and George Stegeman, "*Multiple Quadratic Soliton Generation and Its Control By Weak Beams in Non-critically Phase-Matched Crystals*", IQEC'2002, Moscow Russia, June 22-28 2002, paper QSuF4

82. Hongki Kim, Ladislav Jankovic, George Stegeman, David Eger, Mordechai Katz, Silvia Carrasco and Lluis Torner, "*Second Harmonic Generation Tuning Curves For Focused Input Beams and Spatial Soliton Generation in Periodically Poled Bulk KTP Crystal*", Nonlinear Optics: Materials, Fundamentals and Applications, Maui Hawai, July 29-Aug. 2, 2002, paper ThD4

83. Roland Schiek, Reinhard Neumeier, Robert Iwanow, George I. Stegeman, Gerhard Schreiber, and Wolfgang Sohler, "*Spatial soliton families in lithium niobate slab waveguides with engineered QPM gratings*", Nonlinear Optics: Materials, Fundamentals and Applications, Maui Hawai, July 29-Aug. 2, 2002, paper TuC3

84. Sergey V. Polyakov and George I. Stegeman, "*Quadratic Solitons in Anisotropic Media*", Nonlinear Optics: Materials, Fundamentals and Applications, Maui Hawai, July 29-Aug. 2, 2002, paper TuC4

85. Joachim Meier, George Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "*Spatial Scanning By Phase Controlled Discrete Beam Interactions in Kerr AlGaAs Waveguide Arrays*", Nonlinear Optics: Materials, Fundamentals and Applications, Maui Hawai, July 29-Aug. 2, 2002, postdeadline paper PD9

86. Joachim Meier, George Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "*Discrete Vector Kerr Spatial Solitons in AlGaAs Array Waveguides*", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, paper NLTuA3

87. Thomas Pertsch, Ulf Peschel, Falk Lederer, Joachim Meier, Roland Schiek, Robert Iwanow, George Stegeman, Yoo Hong Min and Wolfgang Sohler, "*Discrete Solitons in $\chi^{(2)}$-waveguide arrays*", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, paper NLTuA1

88. Silvia Carrasco, Hongki Kim, George Stegeman and Lluis Torner, "*Self-focusing of light mediated by cubic nonlinearities in potassium titanyl phosphate*", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, paper NLTuD37

89. G. Stegeman, R. Malendevich, R. Schiek, R. Iwanow, L. Jankovic, H. Fang, G. Schreiber, W. Sohler and L. Torner, "*Nonlinear Beam Dynamics in $\chi^{(2)}$ Waveguides*", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, paper NLWB8

90. R. Schiek, R. Iwanow, G. I. Stegeman, G. Schreiber, and W. Sohler, "*Distortion and improvement of the formation of quadratic spatial solitons by temporal walk-off and wave-*

vector-mismatch non-uniformities", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, paper NLTuD47

91. Silvia Carrasco, Lluis Torner,Hongki Kim, Sergey Polyakov, Ladislav Jankovic, George I. Stegeman and Mordechai Katz, "*Soliton birth from radiation*", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, postdeadline paper

92. Joachim Meier, George Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "*Phase-Controlled Nonlinear Beam Interaction in Kerr-Nonlinear Waveguide Arrays*", Nonlinear Guided Wave Phenomena: Physics and Applications, Stresa Italy, Sept. 1-4, 2002, postdeadline paper

93. Sergey V. Polyakov and George I. Stegeman, "*Properties of Anisotropic Quadratic Solitons*", OSA Annual, Sept. 29-Oct. 4 2002, Orlando, paper ThH2

94. Ladislav Jankovic, Roman Malendevich, Sergey Polyakov, HongKi Kim, George Stegeman, Christian Bosshard and Peter Gunter, "*Multi-Quadratic-Soliton Generation in Potassium Niobate*", OSA Annual, Sept. 29-Oct. 4 2002, Orlando, paper ThY2

95. J. Meier, G. Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti, and J.S. Aitchison, "*Discrete Vector Kerr Solitons in AlGaAs Waveguide Arrays*", OSA Annual, Sept. 29-Oct. 4 2002, Orlando, paper ThBB3

96. Robert Iwanow, Roland Schiek, George Stegeman, Thomas Pertsch**,** Falk Lederer**,** Yoo Hong Min and Wolfgang Sohler, **"***Discrete $\chi^{(2)}$ Soliton in PPLN Waveguide Arrays***",** OSA Annual, Sept. 29-Oct. 4 2002, Orlando, paper ThBB4

97. E. Ultanir. G.I. Stegeman, D.Michaelis, and F. Lederer, "*Investigation of spatial solitons in semiconductor optical amplifiers"*, OSA Annual, Sept. 29-Oct. 4 2002, Orlando, paper WT3

98. Hongi Kim, Ladislav Jankovic, George Stegeman, Mordechai Katz, David Eger, Silvia Carrasco and Lluis Torner "*Spatial solitons in PPKTP*", LS'18, Sept. 29-Oct. 4 2002, Orlando, paper ThY5

99. R. K. Squier, *Ballistic Computing Using Collisions of Optical Solitons*, colloquium at Georgetown University, Jan. 2003.

100. A. Schauer, R. Morandotti, I.V. Mel'nikov, J.S. Aitchison, J. Meier G. I. Stegeman, G. Salamo and H. Yang, "*Deflection and energy exchange between colliding Kerr solitons of orthogonal polarization*", CLEO'2003, Baltimore, paper ThN7

101. E. A. Ultanir, G. I. Stegeman, D. Michaelis, F. Lederer and C. Lange,"*Stable Spatial Autosolitons in Semiconductor Amplifiers*", CLEO'2003, Baltimore, paper TuF7

102. Joachim Meier, George Stegeman, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "*Interaction of Coherent Beams in Kerr Nonlinear Waveguide Arrays*", QELS'2003, Baltimore, ThK2

103. Joachim Meier, Jared Hudock, George Stegeman, Demetrios Christodoulides, H.S. Eisenberg, Y. Silberberg, R. Morandotti and J.S. Aitchison, "*Discrete Vector Solitons in Kerr Nonlinear Waveguide Arrays*", QELS'2003, Baltimore, paper WA30

104. Ladislav Jankovic, Hongki Kim, Sergey Polyakov, George Stegeman, Christian Bosshard and Peter Gunter, "*Collisions of two-dimensional quadratic solitons in type I non-critically phase matched* $KNbO_3$", QELS'2003, Baltimore, MC3

105. Robert Iwanow, Roland Schiek, George Stegeman, Thomas Pertsch, Falk Lederer, Yoo Hong Min and Wolfgang Sohler "*Discrete quadratic solitons in waveguide arrays*", QELS'2003, Baltimore, paper ThK4

106. Silvia Carrasco, Hongki Kim, Sergey Polyakov, Ladislav Jankovic, George I. Stegeman, Juan P. Torres, Lluis Torner and Mordechai Katz, "*Observation of multiple soliton generation mediated by amplification of asymmetries*", QELS'2003, Baltimore, paper MC5

107. Erdem A. Ultanir, George I. Stegeman, and Christoph H. Lange "*Observation of coherent dissipative soliton interactions*", Optics in the Southeast 2003, November, 2003. paper SE 01-A5

108. J. Hudock, N. K. Efremidis, and D. N. Christodoulides, "*Diffraction management and elliptic discrete solitons in two-dimensional waveguide array lattices*", paper QMC4, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

109. N. K. Efremidis, J. Hudock, and D. N. Christodoulides, "*Discrete Ginzburg-Landau solitons in laser arrays*", paper QMC6, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

110. O. Cohen, T. Schwartz, J. Fleischer, M. Segev, and D. N. Christodoulides, "*Multi-band vector solitons in waveguide arrays*", paper QMC7, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

111. B. Freeman, T. Carmon, M. Segev, and D. N. Christodoulides, "*Observation of optical spatial shock-waves*", paper CThE3, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

112. H. Martin, Z. Chen, E. Eugenieva, and D. N. Christodoulides, "*Interaction of a light beam with light-induced photonic lattices*", paper QThK3, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

113. H. Buljan, M. Soljacic, N. K. Efremidis, D. N. Christodoulides, and M. Segev, "*White light solitons*", paper QTuG24, CLEO/QELS 2003, Baltimore, Maryland, June 1-6, 2003.

114. D. N. Christodoulides, "*Soliton based fiber-optic communication systems*", NFOEC, Orlando, Florida, Sept. 10, 2003.

115. O.Cohen, J. W. Fleischer, M. Segev, D. N.Christodoulides, School of Optics/CREOL, "*Grating mediated waveguide*", paper WW7, OSA Annual Meeting, Tucson, Arizona, October 5-9, 2003.

116. O. Cohen, H. Buljan, J. Fleischer, T. Schwartz, M. Segev, Z. Musslimani, N. K. Efremidis, and D. N. Christodoulides, "*Random phase solitons in nonlinear photonic lattices*", post-deadline paper, PD 1.5., IEEE/LEOS 2003, Tucson, Arizona, October 26-30, 2003

117. V. Baby, B. C. Wang, L. Xu, I. Glesk, and P. R. Prucnal, "*Scalable OTDM Transmitter with full Multicast Capability*" 2003 IEEE LEOS Annual Meeting Conference Proceedings Vol. 1, Oct. 29-30, 2003, pp. 548-549.

118. P. Patel, V. Baby, L. Xu, D. Rand, I. Glesk, and P. R. Prucnal, "*A Scalable Wavelength-hopping, Time-spreading Optical-CDMA System*" 2003 IEEE LEOS Annual Meeting Conference Proceedings Vol. 2, Oct. 29-30, 2003, pp. 1048-1049.

119. I. Glesk, L. Xu, D. Rand, and P. R. Prucnal, "*Fiber Ring Laser with Computer Controlled Wavelength Tunability*" 4th Electronic Circuits and Systems Conference, In ECS'03 Conference Proceedings, pp.183-186, Bratislava, Slovakia, Sep. 11-12, 2003.

120. Ivan Glesk, Lei Xu, Varghese Baby, and Paul R. Prucnal, "*All-optical wavelength conversion using SOA at nearly symmetric position in a fiber-based Sagnac interferometric loop*," Photonics in Switching 2003. Sep.28 - Oct.2, 2003, Versailles (Paris), France, pp.119-121.

121. V. Baby, L. Xu, I. Glesk, and P. R. Prucnal, "*Highly scalable serial-parallel optical delay line*" CLEO/QELS 2003, Technical Digest CD-ROM, paper CThX4, pp. 83-84, Baltimore Convention Center, Baltimore, MA USA, June 1-6, 2003.

122. X. Mu, Y. J. Ding, Z. Wang, and G. J. Salamo, "*Formation of InGaAs/GaAs quantum-well dots by using self-assembled InAs quantum dots as stressors*," CLEO'03.

123. Y Tang, A Guo, B Liang, Segev and G J. Salamo, "*Forming 2D in PR ferroelectric crystal by holographic technique*", May, CLEO'03.

124. A. Guo, Y. Tang, W. Black and G. J. Salamo, *"Diffraction management in 2D waveguide arrays"*, May, CLEO'03

125. X. Mu, Y. J. Ding, Z. Wang, G. J. Salamo, and J. B. Khurgin, "*Resonant phonon-assisted electron intervalley up-transfer in type-II GaAs/AlAs superlattices,"* CLEO'03.

126. H Wen, Z Wang, and G Salamo, *"Growth and characterization of InAs epitaxial layer on GaAs(111)B",* MRS, Fall Meeting 2003.

127. S Seydmohamadi, Z M. Wang, V R. Yazdanpanah, and G J. Salamo, *"(In,Ga)As heteroepitzxial growth on GaAs(331)"* MRS, Fall Meeting 2003.

128. Seong Oh Cho, Zhiming Wang, and Gregory J. Salamo, *"(In,Ga)As/GaAs nanostructure evolution at high growth temperature"* MRS, Fall Meeting 2003.

129. J. Meier, G. I. Stegeman, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel, and J.S. Aitchison, "*Beam Interactions with a "Blocker" Soliton in 1D Arrays*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004, post-deadline paper

130. L. Jankovic, H. Kim, G. I. Stegeman, S. Carrasco, L. Torner and M. Katz , "*Soliton Self-Reflection At A Quadratically Nonlinear Interface*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004, paper TuC19

131. R. Iwanow, G. I. Stegeman, R. Schiek, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "*Multi-channel discrete quadratic solitons in periodically poled lithium niobate waveguide arrays*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004, paper MA7

132. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "*First Observation of Discrete Modulational Instability in AlGaAs Waveguide Arrays*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004, paper TuD1

133. E. A. Ultanir, G. I. Stegeman, C. H. Lange, and F. Lederer, "*Coherent Interactions Between Dissipative Spatial Solitons*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004 , paper TuD1

134. R. Schiek, R. Iwanow, G. Stegeman, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "*Low power transparent switching in quadratic nonlinear waveguide arrays*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004, paper TuA1

135. T. Pertsch, F. Lederer, R. Schiek, R. Iwanow, G.I. Stegeman, F. Lederer, Y. Min and W. Sohler "*Parametric switching and frequency conversion in PPLN directional couplers*", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, Toronto March 2004, paper TuA3

136. E. A. Ultanir, G. I. Stegeman, C. H. Lange, and F. Lederer, "*Interactions between "dissipative" spatial solitons in SOAs with automatic signal restoration*", CLEO/IQEC'2004, San Francisco May 2004, paper CMX3

137. R. Iwanow, R. Schiek, G. I. Stegeman, T. Pertsch, U. Peschel, F. Lederer, Y. H. Min, W. Grundkötter, and W. Sohler, *"Parametric switching and frequency conversion in PPLN directional couplers"*, CLEO/IQEC'2004, San Francisco May 2004, paper CFJ4

138. R. Iwanow, G. I. Stegeman, R. Schiek, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "Moderately localized discrete quadratic solitons in periodically poled lithium niobate waveguide arrays", CLEO/IQEC'2004, San Francisco May 2004, paper JTuF5

139. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "*Modulational instability in discrete optics*", CLEO/IQEC'2004, San Francisco May 2004, paper JTuF3

140. L. Jankovic, H. Kim, G. I. Stegeman, S. Carrasco, L. Torner and M. Katz, "*Quadratic soliton self-routing: Intensity dependent soliton reflection at an engineered PPLN dislocation*", CLEO/IQEC'2004, San Francisco May 2004, paper ITuH1

141. R. Iwanow, G. I. Stegeman, R. Schiek, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "Bistable coherent switching in PPLN waveguide arrays", OSA Topical Meeting On Nonlinear Optics and its Applications, Hawaii August 2004, paper MB4

142. R. Schiek, R. Iwanow, G. I. Stegeman, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "Staggered and unstaggered solitons in quadratically nonlinear lithium niobate waveguide arrays", OSA Topical Meeting On Nonlinear Optics and its Applications, Hawaii August 2004, paper MB3

143. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "*Blocking Beam Interactions in 1D Waveguide Arrays*", OSA Topical Meeting On Nonlinear Optics and its Applications, Hawaii August 2004, paper MB6

144. D. Rand, K. Steiglitz, P. R. Prucnal, "*Vacuum-induced fluctuations of Manakov solitons based on a linearization approximation*", 17th Annual Lasers and Electro Optics Society Meeting, Rio Mar, Puerto Rico, Nov. 7-11, 2004.

145. D. Rand, K. Steiglitz, P. R. Prucnal, "*Noise-immune universal computation using Manakov soliton collision cycles*," Nonlinear Guided Waves and Their Applications Topical Meeting, Toronto, Canada, April 4-7, 2004.

146. Lei Xu,.I. Glesk, and P. R Prucnal, "*Optical thresholding using the TOAD*", LEOS 2004, Puerto Rico, November, to be presented

147. Lei Xu, I. Glesk, and P. R Prucnal, "FSK for MPLS, "FSK for MPLS," LEOS 2004, Puerto Rico, November, to be presented

148. G. Bartal, J. W. Fleischer, O. Cohen, O. Manela, M. Segev, J. Hudock, and D. N. Christodoulides; "*Observation of vortex-ring "discrete" solitons in 2D photonic lattices*" , paper MA3, Nonlinear Guided Waves and their Applications, NLGW, Toronto, Canada, March 29-31, 2004.

149. N. K. Efremidis, J. Hudock, D. N. Christodoulides, J. W. Fleischer, O. Cohen, M. Segev; "*Two-dimensional optical discrete/lattice solitons*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper MA8,

150. B. Freedman, O. Cohen, Jason W. Fleischer, Mordechai Segev, Demetrios N. Christodoulides; "*Grating mediated waveguiding and holographic solitons*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper MB7.

151. N. K. Efremidis, J. Hudock, D. N. Christodoulides; "*Bloch oscillations and solitons in Discrete Ginzburg-Landau lattices*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper TuC25.

152. J. Hudock, N. K. Efremidis, D. N. Christodoulides; "*Diffraction management and elliptic discrete solitons in two-dimensional waveguide arrays*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper TuC36.

153. K. Hizanidis, S. Droulias, I. Tsopelas, N. Efremidis, D. Christodoulides; "*Coupled circular arrays of optical amplifiers*", Nonlinear Guided Waves and their Applications, NLGW, Toronto, Canada, March 29-31, 2004, paper TuC39

154. O. Katz, T. Carmon, T. Schwartz, M. Segev, D. N. Christodoulides; "*Observation of elliptic incoherent spatial solitons*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper TuD7.

155. H. Buljan, O. Cohen, J. W. Fleischer, T. Schwartz, M. Segev, Z. H. Musslimani, N. K. Efremidis, and D. N. Christodoulides; "*Random-phase solitons in nonlinear periodic lattices*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper WB3.

156. Z. Chen, H. Martin, D.N. Christodoulides; "*Discrete solitons/soliton-trains in two-dimensional photonic lattices induced with partially-coherent light*", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper WB5.

157. S. Aitchison, D. Christodoulides, Y. Kivshar, D. Mandelik, R. Morandotti, Y. Silberbrerg, M. Sorel, A. Sukhorukov, "*Observation of discrete gap solitons in binary*

waveguide arrays", Nonlinear Guided Waves and their Applications, Toronto, Canada, March 29-31, 2004, paper PD5.

158. N. K. Efremidis, J. Hudock, D. N. Christodoulides, J. W. Fleischer, O. Cohen, and M. Segev, "*Two-dimensional optical discrete/lattice solitons*", CLEO/IQEC 2004, San Francisco, California, May 16-21, 2004, paper JTuD4.

159. J. W. Fleischer, G. Bartal, O. Cohen, O. Manela, M. Segev, J. Hudock, and D. Christodoulides, "*Observation of vortex-ring discrete solitons in 2D photonic lattices*", CLEO/IQEC 2004, San Francisco, California, May 16-21, 2004, paper JTuD5.

160. H. Buljan, O. Cohen, J. Fleischer, T. Schwartz, M. Segev, Z. Musslimani, N. Efremidis, and D. Christodoulides, "*Random-phase solitons in nonlinear periodic lattices*", CLEO/IQEC 2004, San Francisco, California, May 16-21, 2004, paper JTuF2.

161. O. Katz, T. Carmon, T. Schwartz, M. Segev, and D. N. Christodoulides, "Observation of elliptic incoherent spatial solitons", paper ITuH6, CLEO/IQEC 2004, San Francisco, California, May 16-21, 2004.

162. M. Segev, O. Cohen, H. Buljan, J. Fleischer, T. Schwartz, Z. Musslimani, N. Efremidis, and D. N. Christodoulides, "*Random-phase solitons in nonlinear periodic lattices*", Nonlinear Optics, Waikoloa-Hawaii, August 2-6, 2004, paper MB2.

163. E. A. Ultanir, G. I. Stegeman, C. H. Lange, and F. Lederer, "*Interactions between "dissipative" spatial solitons in SOAs with automatic signal restoration*", CLEO/IQEC'2004, San Francisco May 2004, paper CMX3

164. R. Iwanow, R. Schiek, G. I. Stegeman, T. Pertsch, U. Peschel, F. Lederer, Y. H. Min, W. Grundkötter, and W. Sohler, *"Parametric switching and frequency conversion in PPLN directional couplers",* CLEO/IQEC'2004, San Francisco May 2004, paper CFJ4

165. R. Iwanow, G. I. Stegeman, R. Schiek, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "*Moderately localized discrete quadratic solitons in periodically poled lithium niobate waveguide arrays*", CLEO/IQEC'2004, San Francisco May 2004, paper JTuF5

166. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "*Modulational instability in discrete optics*", CLEO/IQEC'2004, San Francisco May 2004, paper JTuF3

167. L. Jankovic, H. Kim, G. I. Stegeman, S. Carrasco, L. Torner and M. Katz, "*Quadratic soliton self-routing: Intensity dependent soliton reflection at an engineered PPLN dislocation*", CLEO/IQEC'2004, San Francisco May 2004, paper ITuH1

168. R. Iwanow, G. I. Stegeman, R. Schiek, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "*Bistable coherent switching in PPLN waveguide arrays*", OSA Topical Meeting On Nonlinear Optics and its Applications, Hawaii August 2004, paper MB4

169. R. Schiek, R. Iwanow, G. I. Stegeman, T. Pertsch, F. Lederer, Y. Min and W. Sohler, "*Staggered and unstaggered solitons in quadratically nonlinear lithium niobate waveguide arrays*", OSA Topical Meeting On Nonlinear Optics and its Applications, Hawaii August 2004, paper MB3

170. J. Meier, G. I. Stegeman, D. N. Christodoulides, Y. Silberberg, R. Morandotti, H. Yang, G. Salamo, M. Sorel and J.S. Aitchison, "*Blocking Beam Interactions in 1D Waveguide Arrays*", OSA Topical Meeting On Nonlinear Optics and its Applications, Hawaii August 2004, paper MB6

171. T. Pertsch, R. Schiek, R. Iwanow, G. I. Stegeman, U. Peschel, F. Lederer, Y. Min, and W. Sohler, "Direct Measurement of Photonic Band Structures by Second Harmonic Generation", QELS'2005, (Digest of QELS/CLEO 2005, Optical Society of America, Washington, 2005), paper QThK4

172. R. Iwanow, D. May-Arrioja1, D. N. Christodoulides, G. I. Stegeman, Y. Min, W. Sohler, "Observation of the Discrete Talbot Effect", QELS'2005, (Digest of QELS/CLEO 2005, Optical Society of America, Washington, 2005), paper QFA3

173. J. Meier, G. I. Stegeman, D. N. Christodoulides, R. Morandotti, H. Yang, G. Salamo, M. Sorel, Y. Silberberg and J.S. Aitchison, "Incoherent Blocker Soliton Interactions in Kerr Waveguide Arrays", QELS'2005, (Digest of QELS/CLEO 2005, Optical Society of America, Washington, 2005), paper QTuL2

174. J. Meier, G. I. Stegeman, D. N. Christodoulides, R. Morandotti, H. Yang, G. Salamo, M. Sorel, "Optical Routing by Sequential Incoherent Blocker Soliton-Control Beam Interactions in Kerr Waveguide Arrays", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, (Digest of NLGW 2005, Optical Society of America, Washington, 2005), Dresden Germany, September 2005, paper TuC1

175. A. Betlej, S. Suntsov, R. El-Ganainy, D. N. Christodoulides, G. I. Stegeman1, J. Fini, R. T. Bise, and D. J. DiGiovanni, "All-Optical Switching in a Dual Core Photonic Crystal Fiber", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, (Digest of NLGW 2005, Optical Society of America, Washington, 2005), Dresden German, September 2005, paper TuD5

176. S. Suntsov, K. G. Makris, D. N. Christodoulides, G. I. Stegeman, A. Hache, R. Morandotti, H. Yang, G. Salamo and M. Sorel, "Nonlinear Tamm states in waveguide lattices", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, (Digest of NLGW 2005, Optical Society of America, Washington, 2005), Dresden German, September 2005, paper ThC4

177. R. Iwanow, D. May-Arrioja, D. N. Christodoulides, G. I. Stegeman, Y. Min and W. Sohler, "Observation of the Discrete Talbot Effect", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, (Digest of NLGW 2005, Optical Society of America, Washington, 2005), Dresden German, September 2005, paper TuC5

178. D. Rand, K. Steiglitz, P. R. Prucnal, "Quantum phase noise reduction in soliton collisions." IEEE/LEOS 2005 Sydney, Australia, October 2005

179. S. Droulias, N. Moshonas, Y. Kominis, K. Hizanidis, J. Meier, N. Efremidis, and D. Christodoulides, "H-waves in nonlinear AlGaAs waveguide arrays", paper QMI16, CLEO/QELS, Baltimore, Maryland, May 22-27, 2005.

180. K. Makris, H. Sarkissian, D. Christodoulides, and G. Assanto, "Incoherent spatial solitons in nematic liquid crystals" , paper QTuL4, CLEO/QELS, Baltimore, Maryland, May 22-27, 2005.

181. Y. Kominis, N. Moshonas, P. Papayiannis, S. Droulias, N. Efremidis, K. Hizanidis, and D. Christodoulides, "Spatio-temporal X waves in highly nonlinear systems, paper JWB93, CLEO/QELS, Baltimore, Maryland, May 22-27, 2005.

182. Y. C. Chua, Jie Liang, B. S. Passmore, E. A. DeCuir, M. O. Manasreh, Zhiming Wang, and G. J. Salamo "Intersubband transitions in In0.3Ga0.7As/GaAs multiple quantum dots of varying dot-sizes" Mater. Res. Soc. Symp. Proc. 829, 15-20 (2005).

183. Sh. Seydmohamadi, H. Wen, Zh.M. Wang, and G.J. Salamo "Controlling (In,Ga)As Quantum Structures on High Index GaAs Surfaces" Mater. Res. Soc. Symp. Proc. 849, KK1.8.1-KK1.8.6 (2005)

184. J. W. Fleischer, G. Fu, Y. Tang, A. Guo, M. Segev, G. Salamo, "Observation of Modulational Instability in Photonic Band Gaps", (Digest of QELS/CLEO 2005, Optical Society of America, Washington, 2005), paper QMF1.

185. G. J. Salamo, Y. Tang, A. Guo, Jason W. Fleischer, "Observation of a 1D and 2D Dark Notch Formed in a Quadratic Photorefractive Medium", (Digest of QELS/CLEO 2005, Optical Society of America, Washington, 2005), paper JThE16.

186. X. Wang, C-K. Shih, J. Zhang, W. Ma, G. J. Salamo, M. Xiao, Enhanced Phonon-Assisted Absorption of InGaAs Quantum Dots Confined in a Planar Microcavity, (Digest of QELS/CLEO 2005, Optical Society of America, Washington, 2005) paper JTuC100.

187. M. Chauvet, G. Fu, A. Guo, M. Segev, G. Salamo, and J. W. Fleischer "Experimental Observation of Discrete Modulation Instability in 1-D Photorefractive Array", OSA Topical Meeting on Nonlinear Guided Wave Phenomena, (Digest of NLGW 2005, Optical Society of America, Washington, 2005), September 2005, paper WD39

6d Manuscrips submitted, but not published

1. E. A. Ultanir, D. N. Christodoulides and G. I. Stegeman, "Spatial Modulation Instability in Periodically Patterned Semiconductor Optical Amplifiers", JOSA B, **in press**

2. S. Suntsov, K. G. Makris, D. N. Christodoulides, G. I. Stegeman, A. Hache, R. Morandotti, H. Yang, G. Salamo and M. Sorel, “Observation of surface discrete solitons”, Phys. Rev. Lett., **in press**

2. **Scientific personnel**:

Dr. Demetrios Christdoulides (co-PI, Lehigh University 2000-2003, CREOL 2003-2005)
Dr. Steve Forrest (co-PI, Princeton University 2000-2003)
Dr. Greg Salamo (co-PI, University of Arkansas)
Dr. Moti Segev (co-PI, Princeton University/Technion Israel)
Dr. Richard Squier (co-PI, Georgetown University)
Dr. George I. Stegeman (PI, CREOL, University of Central Florida)

Dr. Joseph Giordmaine (Senior Research Collaborator, Princeton University, 2000-2003)
Ivan Glesk (Research Scientist, Princeton University)
Dr. Song Lan, (post doctoral fellow, Princeton University, 2002-2003)
Dr. Jason Fleischer (post doctoral fellow, Princeton University & Technion, Israel, 2001-2004)
Dr. Hrvoje Buljan (post doctoral fellow, Princeton University & Technion, Israel, 2004)
Dr. Eugenia Eugenieva (post doctoral fellow, Lehigh University, 2000-2002)
Dr. Nikos Efremidis (post doctoral fellow, Lehigh University/CREOL, 2001-2004)
Dr. Hongki Kim (Postdoctoral Fellow, CREOL, 2001-2003)
Dr. Roland Schiek (visiting faculty, CREOL, 2004)
Dr. Alain Hache (sabbatical visitor, CREOL, 2005)
Dr. Natarajan Ganesan (visiting faculty, Georgetown University, 2004-2005)

Aqiang Guo (graduate student, University of Arkansas, PhD awarded 2003)
Gary Russell (graduate student, University of Arkansas, PhD awarded 2003)
William Black (graduate student, University of Arkansas, 2002-)
Y. Tang (graduate student, University of Arkansas, 2003-)
Ryan Swain (graduate student, University of Arkansas, 2003-)
G. Fu (graduate student, University of Arkansas, 2003-)
Jared Hudock (graduate student, CREOL, PhD awarded 2005)
Ladislav Jankovich (graduate student, CREOL, PhD awarded 2004)
Roman Malendevich (graduate student, CREO, PhD awarded 2001)
Joachim Meier (graduate student, CREOL, PhD awarded 2004)
Sergey Polyakov (graduate student, CREOL, PhD awarded 2003)
Erdem Ultanir (graduate student, CREOL, PhD awarded 2004)
Robert Iwanow (graduate student, CREOL, PhD awarded 2005)
Sergiy Suntsov (graduate student, CREOL, 2003-)
Arek Beltej (graduate student, CREOL, Masters awarded 2005)
Tony Ho (graduate student, CREOL, 2004-)
Georgios Sivologou (graduate student, CREOL, 2004-)
Thomas Peschel, (PhD student, visiting CREOL from Friederich Schiller University, 2002)
Adrian Schauer, (MSc. student, visiting CREOL from University of Toronto, 2002)
Patrick Laycock (graduate student, CREOL, Masters awarded in 2004)
Costantinos Makris (Ph.D. student, CREOL, 2003-)
Parchi Partel (graduate student, Princeton University, Masters awarded in 2002)
Bing Wang (graduate student, Princeton University, PhD awarded 2004)

Lei Xu (graduate student, Princeton University, PhD 2003)
Varghese Baby (graduate student, Princeton University, 2003-)
Darren Rand (Ph.D. student, Princeton University, 2003-)
Charalambos Anastassiou (graduate student, Princeton University, PhD awarded 2001)
Song Lan (graduate student, Princeton University, PhD awarded 2002)
Suzanne Sears (graduate student, Princeton University, PhD awarded 2002)
Marin Soljacic (Ph.D student, Princeton University, PhD awarded 2000)

Catherine Debassio (undergraduate student assistant, Georgetown University, 2000-2003)
Seth Whitaker (undergraduate student assistant, Georgetown University, 2000-2003)
Yan Bulgak (undergraduate student assistant, Georgetown University, 2000-2001)
Reinhard Neumeier (undergraduate student, visiting from Technical Un. of Munich, CREOL, 2003)
Jasmine Milner (undergraduate student assistant, Georgetown University, 2001-2003)
Denitsa Apostolova (undergraduate student assistant, Georgetown University, 2001-2003)
Tobias Schmid, (undergraduate student, Techn. Un. Munich, 2004)
Emre Togan (undergraduate thesis student, Bilkent University, Turkey), 2003)
Marco Affolter (undergraduate thesis student, ETH Zurich, Switzerland), 2003)
Pierre Abouisiniere (undergraduate thesis student, Un. Nice, France, 2004)
Francois Nguyen (undergraduate thesis student from Ecole Polytechnique, France, 2004)

3. <u>Technology Transfer</u>

During years 2003 Several potential licensees were identified. One such licensee, a start-up company called Kailight, Inc., negotiated an exclusive license with the University for a limited term. Kailight has been developing, based upon this IP, all-optical signal processing products for the long-haul telecommunications market. Discussions have recently begun with a third potential licensee Fiberspan, Inc. Continuing to process these patent applications will depend on the continued support of these licensees, which at this time is highly sensitive to the telecommunications marketplace.

Invention report:

With the partial support of the MURI program, researchers at Princeton University have generated intellectual property based on their investigations of gateless solitonic computing. This IP was derived, in part, from their investigations of multi-dimensional solitonic switching, including spatial and temporal solitonic switching architectures, all-optical i/o processing, and the interface of spatial solitonic processors to temporal solitonic transmission systems.
As indicated in the list below, this IP has resulted in several patent applications with the U.S. Patent Office, several provisional patent applications, and several invention disclosures to the Princeton University Office of Patents and Technology Licensing that have not yet been filed. Princeton's policy is, when appropriate after receiving an invention disclosure, to file a provisional application with the U.S. Patent Office. This is not always done because of cost considerations. If a potential licensee is identified that is willing to assume the prosecution costs of filing a full patent application, then a patent application may be filed with the U.S. Patent Office as well. This has been done in

several cases, in which potential licensees were identified

Patents issued

US patent #6,535,662 TOAD Having Enhanced Extinction Ratio of the Switching Window. Issued 03/18/03

Patent applications filed:

An All-Optical Wavelength Converter Based on Sagnac Interferometer with SOA at Asymmetric Position. Inv. #04-2061-1; 09/08/03